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CHEMICAL & METALLURGICAL ENGINEERING

New York, May 26, 1920 McGraw-Hill Co., Inc. Vol. XXII, No. 21, 25c. a copy

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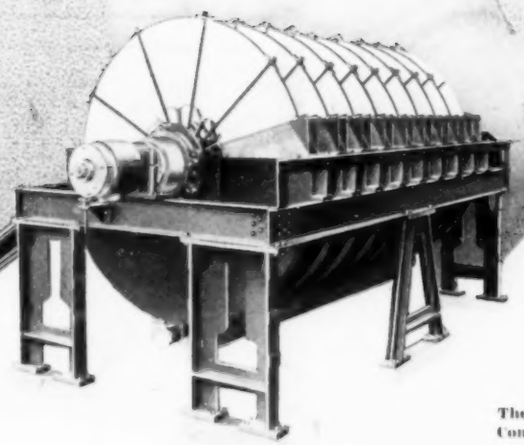

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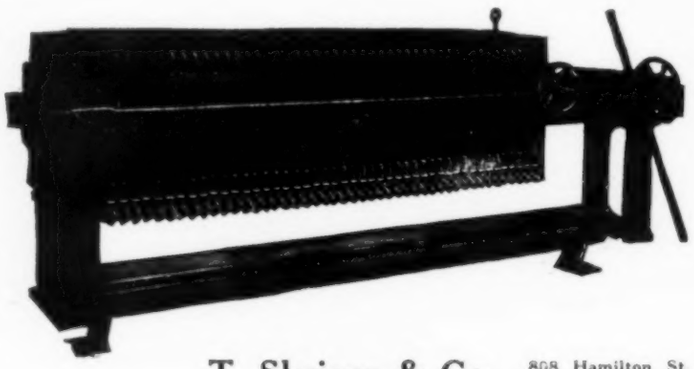

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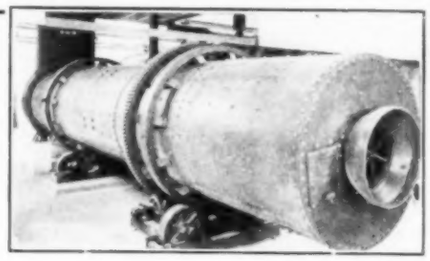

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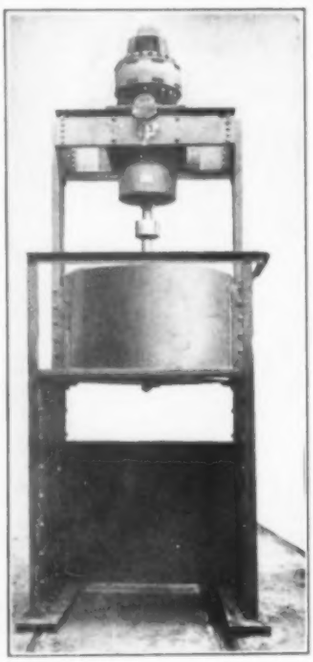

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Congress and the Air Nitrate Projects

THE special House Committee of War-Time Expenditures on Air Nitrate Projects by the Government has made its majority and minority reports, as recounted at considerable length on our news pages. This conforms to Congressional tradition, which is the same as that of country lawyers. The Speaker appointed a majority of his own party and a minority of the opposition to the committee, and its members straightway established themselves as attorneys for their respective parties. The people were hardly represented.

The principal recommendation of the majority related to the big Muscle Shoals works and proposed that it be leased and converted into a fertilizer plant for the sale of products direct to farmers with the right of the Government to take it over in time of threatened war.

This is a recommendation in regard to the general welfare. It might very probably be the report that any majority would have made, whether it consisted of Republican or Democratic conservative politicians who shy at anything that smacks of Government control of a specialized industry. But immediately a minority member registered a protest against the report, not on the ground that another alternative was better, but on the ground that it was an invasion of the function of another committee of the House. This was twaddle and it was overruled, but whether it was overruled because it was twaddle or because it was registered by a Democrat, while the Speaker is a Republican, is a secret that will probably always remain hidden in the Speaker's breast—and it is doubtful if he could reveal the truth about it if he tried.

Then the majority condemned the Government's entire war-time program and charged reckless waste and extravagance. They say the blame rests on President WILSON and BERNARD M. BARUCH, Mr. BARUCH being the moving spirit of the war-time project. The assertion, however, has no significance whatever, because, if Mr. WILSON had been a Republican, the same majority would have praised him for doing exactly what he did and admired Mr. BARUCH even beyond his real deserts. And the Democratic minority would have found no merit in it. As it was they found no fault. The majority vote of censure is not a register of opinion; it is merely a register of political tropism.

Then, to put the Administration into a hole, the majority proposed that no further sums be paid to the Air Nitrates Corporation, on the ground that it failed to perform its contract; the institution of civil suits was recommended for recovery of damages, and it was urged that the whole question of pay (i.e., the payment of debts incurred by the Government) be "threshed out" in the Court of Claims. Threshed out is the right expression. The chance of collecting a debt against the Government in the Court of Claims with governmental counter-suits pending is a weary process. If the liquidation can be completed within twenty years it will be speedy work. Members of the majority may strut and shout until they are blue in the face about their integrity of purpose, but they cannot prevent it from appearing that they were willing to cause the Government to default in its obligations rather than miss the chance to embarrass the opposition. There was no effort to serve the people by either side that a careful reader can discover. They did what they had to do to avoid blame for themselves, and devoted the major portion of their efforts to get their opponents into trouble. The whole thing is sickening.

Suppose a commission of engineers were selected to build a smelter, not because of their merit as engineers but to provide a body of men unevenly divided between persons with red hair and those with black. Suppose whatever men of one complexion did the others declared to be wrong and that the whole caboodle of them were more interested in fixing blame on the opposition than in getting the smelter built. What kind of a smelter would result? Then suppose after it was built its operations were carried on by just this sort of "party government." When would dividends begin?

Here we are with the threat of madness over civilization confronting a great part of the world, and the trouble is contagious. And we have not enough strong men of character in Congress to shame their fellows into a sense of their obligations to the people. Nobody wants to know how incompetent the other side is. Everybody knows both sides are incompetent. There is no use in telling us so any more. We do not want the choice of the lesser evil. What we want is the greater good, and vituperation will not bring it to light. What a pity that the men we have elected to represent us cannot understand this!

National Organization Of Engineering Societies

DOUBTLESS all national, regional and local engineering societies have some time since received proper notification from the Joint Conference Committee of the Civil, Mining, Mechanical and Electrical Engineers of the organization meeting to be held at Washington, D. C., on June 3. Therefore it is unnecessary to dwell upon the importance of this item of news, but it is well for engineers in general to think carefully upon the issues which impel the present movement toward a national organization.

It may be said that the Joint Conference Committee is an outcome of a slow accumulation of sentiment in the ranks of the American Society of Civil Engineers,

which after years of growth took visible form in the appointment of a numerous committee on development, to consider ways and means whereby the individual engineer could get more direct advantage in a human rather than a technical way from his engineering society. Other engineering societies took similar action for a variety of reasons which would be tedious to relate, but in all of these committees there was a well-expressed idea that some inclusive organization would be necessary to express properly the engineers' desire for service and influence on such public affairs as they are qualified to speak of with authority, and to consider the welfare of the profession of engineering in its broad general aspects.

Hence the Joint Conference Committee, delegated from committees on development from the four national societies, met and formulated a plan of organization which was duly reported back to the parent institutions. These societies, by appropriate action, approved the plan in principle, and appointed delegates to the forthcoming conference, apparently, however, without power to bind their parent societies to such action as may be taken at Washington.

In fact, the development activities within the Civil Engineers were responsible for a very recent letter ballot, wherein the membership by decisive majorities called for such action as would increase the engineer's influence in public affairs, yet by a small majority rejected the plan advised by the Joint Conference Committee. Briefly, this proposed organization is not intended to be (in the words of one of its sponsors) "a super-society of engineers. It will have no membership of individuals, but will be composed entirely of delegates representing organizations already in existence. In its object it does not encroach on the province of any engineering organization at present in existence."

This last statement may fairly be questioned, as well as doubt expressed as to whether the method of representation will appeal to all engineers any more favorably than it did to the Civils. It may be pointed out that the new organization is not a society, but a federation. The ultimate member will be well represented only in case his particular society is peculiarly responsive to his needs. If memory serves correctly, not so long ago an appeal to American engineers for funds for Engineering Council (in itself an organization having no membership of individuals, but composed entirely of delegates) met with extremely meager response. On the other hand, during the last year the American Association of Engineers increased its membership from 4,000 to 17,000, and received $170,000 for investment in active work of the organization, which indeed seems to include the avowed purposes of both the poverty-stricken Engineering Council and the proposed new federation.

Unquestionably the spirit of unrest is stirring engineers as well as it is any other group of individuals in the present-day world. It is calling for engineering societies which shall justify their existence by service to the individual rather than for their officials. Engineers are worthy of a more influential voice in our public activities, and some organization will spring up to satisfy this demand. But in view of the history of Engineering Council, the Civil Engineers' letter-ballot, and the phenomenal growth of the A.A.E., it can be plainly concluded that the successful society will not be composed of delegates, but rather of individuals.

Inquisitive Ignorance In the Foundry

OF COURSE we younger metallurgists had an inkling of it in our own minds, without immodest self-confidence. Yet it sounded good to hear the gray-headed expert ("expert" is the proper term), the seasoned consultant with his kindly eyes, repeat in all seriousness, "The educated young man now in the foundry is its salvation."

The hearer was feeling pessimistic that morning, and mentioned the fact that perhaps twenty-five years ago there was a great furore to put a chemist into the foundry. No foundry was complete without either a rack of test tubes or a file of analysis reports. Yet even today relatively few of the foundries which delude themselves with "chemical control" really appreciate what "chemical control" means. If the analyses are not laid away to rest alongside innumerable of their brothers on file, no serious effort is made by the melter to see that the charges are actually and carefully weighed. So why should the few technical men going into the foundries be so important?

"I'll grant you that the foundry is full of rule-of-thumb methods, and has a strong tendency to revert to type," said the older man. "When I first worked in a locomotive shop I well remember no one could cast engine cylinders but the HARE boys. If they were both sick, well, there were no cylinders made until they returned. They had their favorite cheeks, and their own peculiar sand. All the molders knew these, but did not know the feel of the sand when it was properly mixed, they would ram it just a bit too hard, or the gaggers would not be bent at the exact crook, or the cope would not be vented just so nor would the HARE boys ever tell just how they determined when the iron was exactly right. They were acknowledged the best molders on engine cylinders, and they intended to remain so.

"That works still remains, and the HARE boys are no longer molding cylinders, yet better engines than ever are turned out every month, and at a tremendous rate, despite the old-timers!

"About ten years ago the management decided to rebuild the rambling assemblage of miscellaneous shops into one consistent manufacturing establishment capable of turning out their steadily increasing business. They employed some real engineers, who studied the requirements of that particular concern, and in the end provided a modern plant containing all the mechanical features the heart could desire. The foundry was an inspiration!

"Naturally, but unfortunately, BILL RIDDLE, who had been foreman of the old foundry for thirty years, was continued in charge of the new plant. The bigger job was too much for him, and in order to be on the safe side, he saw to it that the workmen made car wheels exactly the same in 1910 as they were made in 1885. Of course, expected output did not materialize, nor could anyone tell RIDDLE anything or help him. The way he had done since youth was safe and good enough, and he was going to run the whole plant himself, since he was in charge!

"Finally the manager asked me if I could suggest a way out of their trouble, and I told them that they should select three or four of their best and keenest young men, and impose them upon BILL as assistants. Of course BILL would make a terrible fuss, and lead the

boys a dog's life for a while, but he must be given to understand that all were to work together rather than pull apart.

"In a year or so BILL RIDDLE retired, it is said with dire predictions of the fell consequences. Yet the best of the boys is now superintendent, and the plant is steadily improving and exceeding the designer's predictions. So you can see I have at least one good reason for my abiding and instinctive faith in the genius and capacity of the inquisitive young men coming into the foundry, who do not know so much about the correct way to do things that they are not afraid to put some of their foolish inspirations to trial!"

Inefficient Distribution of Labor

THERE is a "shortage of labor" in the United States. One may say that is a curious if not impossible situation, for if everybody is working and everybody is consuming it cannot make a great deal of difference how many there are all told, whether 50,000,000 or 100,000,000. If there is a shortage of workers why not an equal shortage of consumers, and there you are! It was a different thing at various times in the past when the entire population were consumers or would-be consumers, but through some mischance all could not get jobs, hence could not get the wherewithal to purchase things for consumption.

Large corporations are usually efficiently managed these days, but a large corporation is not well managed merely through having the proper total number of employees. It is in a bad way if it does not have a capable president, and the president's office is in a bad way if it does not have a proper supply of capable office boys. Each job must be properly filled, and the efficiency is not what it should be if there are men who are doing work that is beneath their ability. Everyone should have the opportunity to do the best work he is capable of doing.

The United States is not thus aligned as to its working forces. There is a very inefficient distribution of labor, using the term "labor" in its broadest sense. Thousands of school teachers have resigned from positions where they were very useful, in order to take positions as stenographers and clerks. Janitors and street sweepers get pay far in excess of the proportions formerly obtaining. Men able to do better things are engaged at common labor, but as they don't like that kind of work the common labor has been going to higher and higher premiums. Railroad work has been disorganized by workmen receiving higher pay than the foremen who direct their work.

The way we have been muddling along is that if there is not enough common labor we pay a disproportionately high price for common labor, and if there is still not enough, the more skilled crafts reduce their performance to strike a balance.

When immigration has been shut off for years it is natural that there should be a shortage of common labor, and as each finished product, whether a dwelling house, a skycraper, a steel rail or a bushel of potatoes, requires its certain percentage of unskilled labor and of skilled labor there is a deficiency in production. If skilled workers were working as well as formerly, there would not be enough work for them to do, on account of the lack of the proper proportion of common labor, but they endeavor to bridge the gap by doing less in a day. This may seem well enough to them, although the high cost of living is making some of them think, but in any event it is not efficient. Should competition among skilled workers arise, as there has been competition in the past, it would be found that not enough work could be given them, by reason of the scarcity of men to do the common labor.

The scarcity of common labor is due, of course, to the failure of immigration, and immigration needs to be stimulated, whereas the literacy test, enacted by Congress at the behest of organized labor after successive Presidential vetoes, is one thing that curtails immigration. The country is suffering from lack of common labor, and skilled labor is suffering. Some time it may suffer still more. The question is whether it realizes, or can be brought to realize, its mistake, in opposing immigration. If we had no plumbers and found it much more costly to train plumbers than to allow plumbers from abroad to come into the country, it would certainly be advantageous to bring them in.

It used to be complained that the foreign-born workmen saved up their money and sent it abroad to friends and relatives, or even carried it out of the country with them. We were under the painful necessity of exporting goods to equalize this and other portions of the "unseen balance of trade." Nowadays we bribe men to do common laboring work by paying them high wages and instead of saving their money they buy silk shirts, hence the high cost of living. The silk shirts do not do them any particular good and the man who feels he is really entitled to wear silk shirts is disgruntled.

"Technically and Commercially Successful"

AN ANNOUNCEMENT of a co-operative agreement which has been perfected by the Bureau of Mines with certain individuals for the study of lignite coking and briquetting has been made public. The agreement puts special emphasis upon the desire that there be established "a technically and commercially successful business." Both parties are to be congratulated that there is such definite recognition of two essential elements in any investigational plan.

There is a great deal needed to be known about lignite and its properties, about the products, solid, liquid and gaseous, which result from its carbonization, and about the possibilities of briquetting lignite and lignite chars. It is to be hoped that many of these uncertainties will be cleared up and valuable information afforded our engineering talent for future development of this important fuel resource that today lies practically unexplored and untried.

However, the business side of any such process is just as important to the engineer as the science and technology, and it is very satisfying therefore to find that the two elements so important in the development of this new industry are placed upon a par in the program of work announced. One cannot expect that both elements will be wholly illuminated by such a limited expenditure as the $300,000 which will be invested under this co-operative agreement. However, the very limited knowledge now available in this field should be greatly extended, and the possibility of further future development made much more promising.

Readers' Views and Comments

Engineering Conference on Public Service

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 910 of your May 12 issue you entirely misinterpret the Notice to Engineering Societies. The Organizing Conference, meeting in Washington, June 3 and 4, is not a meeting of the Joint Conference Committee, but is a meeting of representatives of all national and local engineering and technical societies to organize the representative national body which shall embody the "public service" element of all American engineers. The Joint Conference Committee was authorized by the four large engineering societies to issue this call for a conference to organize this body along the lines of the Joint Conference Committee's report to the four large engineering societies.

JOSEPH W. RICHARDS,
Acting Secretary, Joint Conference Committee.

Bethlehem, Pa.

To the Engineers of America

To the Editor of Chemical & Metallurgical Engineering

SIR:—None of the undersigned has been active in "politics" heretofore; nor are we now! But we believe that our country needs just one kind of a man to guide its fortunes during the next four years.

He should be a man understanding the underlying causes of the present nation-wide unrest—the economic as well as the social causes; a man who has administered large affairs successfully, handled vast sums economically and honestly; has employed laborers with sympathy and success; one having executive experience; who has made his way up from humble beginnings and therefore understands the psychology of the man who works with his hands; one who has the courage to combat squarely, whether in the board-rooms of corporations or in the councils of ignorant or vicious "Soviets."

We need a man not only "favoring" economy in the National Administration, but an avowed advocate thereof, with the knowledge gained from experience of how a budget system is prepared and also how it should *work*; in other words, a sane and tried "efficiency expert."

America needs a man who has seen and knows actual conditions overseas and who can guide our international relations with firmness and sympathy, justice and honor; a man who has met face to face and understands those who lead the councils and influence the policies of European nations, new and old; who has had not only the grace to say "Yes," but the courage to say "No!" when necessary, not only to our late enemies, but to some others abroad who would take advantage of American sympathy or generosity—yes, and to some of the few here who would "profiteer."

Some of us know and respect one or more of the men who are seeking in an honorable way to secure the Presidential nomination, and others who are also favorably thought of; *but has anyone of them the first-hand knowledge of our national and international problems that are in the undisputed possession of Herbert Hoover?* We think not!

We believe it is possible that he can be nominated, even without a political machine behind him; that the American people can constitute themselves a "Committee of the Whole" whose choice will be triumphant, *provided the "vox populi" can be made audible!*

How can this be done? By bringing it about that the people shall not only speak out what we believe is in their hearts but that their voice shall be *heard.*

We are members of one or another of the great Engineering Societies of America, but we have neither asked nor do we expect these organizations to act as *such.* But if each engineer, before whom this letter appears, will constitute himself a committee of one, each in his own locality, to spread the well-known facts of Herbert Hoover's career, personality and attainments and *to bring to the delegates of his own state the knowledge of his neighbors' demand* that Hoover shall be the nominee, this result will surely be attained. No one knows better than the political leaders of all parties that if nominated *he is sure to be elected.*

Will the American engineers help to bring this about?

For further information write to the Engineers' Hoover Committee, 480 Lexington Ave., New York.

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An Accounting Mystery

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the issue of April 21 you express regret that the House and Senate had declined to grant a fund to the Bureau of Standards for the preparation and distribution of standard samples. Later, you say that the work was really self-supporting. If it was self-supporting, why is a fund necessary for its continuance? Why can the Bureau not continue to distribute samples and show a profit from it? If it was not self-supporting, why continue to state that it was?

A. A. N.

It is no wonder that A. A. N. is somewhat mystified at the Government accounting system which does not permit a self-supporting fund to be such in effect as well as in name.

With reference to the standard sample fund of the Bureau of Standards, the fund requested is $5,000. The fees last year were $6,000 in cash and $4,000 or more additional in credits for work done for state and Federal departments that do not pay cash. These funds, however, are not available to the Bureau of Standards but go into the Treasury, to the credit of the United States. Therefore, it makes no difference how much money the Bureau takes in in fees, it has absolutely none of it to spend for continuing the work. As a consequence, it might be more nearly correct to say that the work was self-supporting as far as the Government was concerned, but as far as the Bureau of Standards is involved any expenditures it makes cannot be recovered from income, no matter what the fee may be in size or character. [EDITOR.]

Corrosive Action of Soils on Iron and Lead

An Outline of Field and Laboratory Tests on Electrolysis of Metal Parts Buried in Many Soils, Together With a Brief Summary of the Experimental Results and Derived Conclusions

By L. A. STENGER

ONE of the features of industrial conditions little noticed by the average person is the multiplicity of pipe lines, cables, conduits and various other metallic structures found in the subsoils of cities. These structures, with the exception of earthenware sewers and conduits and bituminized fiber conduits, are constructed from cast or wrought iron, steel and lead. The iron and lead are used for water pipes, iron is used for electrical conduits and gas pipes, and lead, usually containing 2 per cent of tin, is used as a protective covering for electric power and telephone cables. Rails of street railways may be included with these structures, also steel foundations of buildings and steel tunnel linings.

Usually these pipes, etc., are placed in the soil with the idea that they will not be affected, at least to the point of destruction, by any corrosive agencies. Attempts are sometimes made to paint or coat the metallic surfaces for protection, more often not.

An enormous amount of work has been done investigating the causes of corrosion of iron and lead in air and the methods for their adequate protection. Comparatively little has been done investigating and preventing corrosion of these metals in soils.

There have been several theories advanced to explain the corrosion of iron. These are the electrolytic, the carbon dioxide or acid, the hydrogen peroxide, the oxidation and the biological or bacterial. From the results of work on this subject, together with a study of the publications of Whitney, Cushman, Gardner, Walker and many others on corrosion in general, the present author believes that practically all corrosion, of both iron and lead, is electrolytic in action.

Corrosive Action of Soil

The general study of the subject was begun with field observations of underground structures in different places. Extensive work of this type was done at Havana, Cuba, in 1911, by S. T. Todd, of the General Electric Co., and the writer. At that time a new sewer system was being installed, the excavations for which offered a rare opportunity for observing the many piping systems buried in the ground. There it was found the corrosive action of the soil on iron was severe. The most damage was done to the smaller iron gas and water service pipes. From reliable information from several sources, it was found their life was from three to seven years, for either wrought iron or steel pipes. A poorly galvanized pipe would corrode as badly as a black pipe. A good heavy galvanized coat was an effective protection. Corrosive action was very marked also on cast iron pipe. Careful work was done to find leakage electric currents where this corrosion occurred. None was found. The street railway rails carry practically no current, the double trolley system being in use. The rails of two electric lines entering the city carried current; these were the only sources of leakage current in the city, and, owing to the good soil conductivity, damage from that current would be localized closely to the lower potential points of the tracks. No damage had been reported from this cause. Furthermore, corrosion had been common in that city before electricity had been used at all, therefore it is absolutely certain the pipes were corroded by reactions between soil constituents and the metal.

In Indiana there was laid in 1891 an 8-in. steel gas pipe with screwed wrought iron couplings. This pipe extended from the Grant County gas fields to Crawfordsville, where it ended about one-half mile from an electric railway. This pipe was taken up in 1911. It was corroded in local areas over the pipe, at many places through the walls, and generally over the whole length of the line. It was buried 3 to 5 ft. deep, lying in moist yellow clay soil. This corrosion was also due to reactions between soil constituents and iron.

In Pierre, S. D., cast iron water pipes have been replaced on account of damage due to soil corrosion only. Small iron service pipes were corroded to leakage in six years. The subsoil there is a heavy clay.

Cast iron and steel pipes have been found in Minneapolis and St. Paul, corroded to destruction in black peat soil, cinder fills and clay. These soils were found to be actively corrosive.

Commercial lead is very long lived under ordinary circumstances. However, in Havana it was found that lead covers of some insulated electric cables laid in earthenware conduits were destroyed in three years. This occurred where silt had leaked into the conduits, and where, at times, water ran through them. The lead water service pipes buried in clay were in an excellent state of preservation, and all observations and information indicated that they were undamaged.

Corrosion Is Electrolytic or Auto-Electrolytic

Consideration of these facts and others leads to the classification of corrosive effects into two types. One, called electrolysis, is the resultant of an outside generated electrical current flowing from the metal by an electrolytic conduction path. The other has been termed auto-electrolysis; it is electrochemical in nature, and nearly all corrosive effects on subsoil structures, not caused from electrolysis, are produced by it. These two types are to be clearly differentiated, although it has been found that their effects are similar, and as they are so nearly related, any study of corrosion should include consideration of each, especially when corrosion causes are under investigation.

Localized corrosive action on iron, commonly called pitting, may easily destroy gas or water pipes, as a leak is caused in a comparatively short time. The

electrolytic theory may be applied to explain such corrosion. Iron has a high solution tension, which causes iron ions to leave its surface under electrolytic conditions, as in moist soils. This ionic travel sets up an electric current. If there is a particle of material electronegative to iron and in contact with it, the current will be directed and will flow from the iron through the adjacent soil to the electronegative area back to the iron. The result will be iron going into solution and becoming oxidized to hydrated iron rust, which is insoluble, porous and an electric conductor. The hydrogen formed by this electrolysis is oxidized to water. If free hydrogen were formed, as in rapid action, the current would be reduced or stopped by insulation due to the gas film on the electronegative area; that is, the miniature battery would be polarized. But it is found by experiment that all the hydrogen is oxidized, and no gas is evolved, and that the action is continuous until the iron is all removed in the immediate vicinity and a pit results. This action is then auto-electrolysis. Any bare iron structure in soil is subject to auto-electrolysis, as the soil will always be more or less an electrolyte, as it contains soluble salts, or acid ions, and moisture.

On account of the number of variable factors found affecting corrosion rates, it becomes rather difficult to isolate and to study them effectively. Considering the metal alone, prominent factors affecting its corrosion rates are constitution, properties of components, segregations, foreign substances including gases, states of strain, solution tension and conditions of surface.

External factors involving the soils and conditions outside of and in contact with the metal are moisture content, gases, composition, electrical conductivity and components. The latter may be chemically corrosive, electronegative to the metal and catalytic in action. Also porosity or density, homogeneity, concentrations, bacterial conditions, temperature and pressure are to be included.

Potential Explorations

At the beginning of some laboratory work done by the writer under direction of Prof. E. E. Nicholson at the University of Minnesota, some experiments were carried out, electrolyzing cast iron and sheet steel in solutions. They show that the iron goes into solution at a rate of 1.042 g. per amp.-hr., approximately. This is with a valence of two. Further work was then done using several irons in different soils, to compare all effects under the various conditions, and to find the corrosion rates both by electrolysis and auto-electrolysis. For electrolysis in soils many tests were run, using different soils and iron, steel and lead anodes. Tests were made on iron anodes with scaled, smooth, or polished surfaces. Various voltages and current strengths were used. After deducting for the corrosion due to auto-electrolysis as determined under the same conditions without any applied electric current, the efficiency of electrolysis was determined. From all results, about two-thirds of the iron anodes having an electrolysis corrosion efficiency under 100 per cent gave an average of 81 per cent efficiency. The remaining 33 per cent of anodes at 100 per cent efficiency and over gave an average of 110 per cent. Lead anodes gave an efficiency of from 80 to 150 per cent. From these results no law connecting any of the variable factors with a definite electrolysis efficiency was noted.

Electrical or galvanic phenomena found in connection with auto-electrolysis were studied. Two identical electrodes of copper (platinum could have also been used) were made, and covered with pads of cotton cloth or filter paper. These terminals were connected to a suitable electrometer. Wetting the pads with dilute acid and placing them on an iron surface, an electromotive force was produced. The resulting current was caused by the iron ions passing into solution at a faster rate in one electrolyte than in the other. The effect is also observed after using soil under the terminals instead of pure acid electrolyte. The energy generated is dependent on various factors, and the voltage is due primarily to the solution tension of the metal.

Current Strength Studied

Studies were made of these potentials and the resulting current strengths. A Weston 15-volt voltmeter is a suitable instrument to use for measurement of voltage with electrodes as described about 1 in. in diameter. This instrument does not indicate the full voltage generated, on account of the limited current flow. A special inclined capillary Lippman electrometer was constructed for this work and found excellent. It takes no current and indicates potential up to 0.8 volt accurately. A Weston milliammeter may be used to measure the current. In making such electrical surveys on bright pure iron, usually the electrode put down first is found to be electropositive. The current flow would be from the iron under it. Using ordinary moist clay as electrolyte and two similar copper terminals, placing one clay first on pure bright iron, and in a few seconds the other in another place on the same piece of iron, closing the circuit with the copper terminals through the Lippman electrometer, voltage up to 0.1 was indicated. The copper terminals may be reversed, also reversing the electrometer, to determine if there is any voltage due to dissimilarity between them—there should be none. Care should be used to avoid contact between terminals and iron.

With this method, using moist soils as electrolytes, potentials were measured between points on many kinds and conditions of irons found in commercial use. On clean ordinary surfaces would be found 0 to 0.1 volt, clean iron to mill scale 0.3 to 0.5, clean iron to copper 0.8 to 1.0, clean iron to carbon 0.8 to 1.0, clean iron to red rust 0.3 volt. The clean iron would be electropositive in all cases; current would leave it and cause corrosion.

Causes of Auto-Electrolysis

The destructive effects of auto-electrolysis depend upon the electronegative material to a considerable degree. If it is a copper coating with a flaw exposing iron, then under auto-electrolytic conditions a hole will be corroded through the iron in a surprisingly short time. A superficial corrosion will expose the graphitic carbon in cast iron; an area is thus electronegative and the iron ions are removed through the porous electrolyte-saturated soft material, characteristic of corroded cast iron. Mill scale, if thick and unbroken, is a good protection to iron, but if broken becomes a source of danger, since it is electronegative. In soils where the electrolytic conditions are not favorable for corrosion, as in clean sand, action may be suspended indefinitely, only a small amount of rust forming.

Corrosion of Purest Ingot Iron

Pitting will occur in polished, pure irons (analysis 1) in a clean well-mixed clay, due to the same causes

with no apparent electronegative areas on the iron itself to direct or localize the reaction. This may be due to either or both the following causes: slight differences in the iron itself, or concentration cells set up in the clay. Using the Lippman electrometer with electrodes of similar metal, preferably small platinum wires, surveys over a piece of moist clay showed potentials of 0.01 to 0.02 volt between different points. Attempts were made in this way to locate the low potential points on a smooth clay surface. Then a polished, pure iron plate was placed on it. Allowing action to continue a few days, the iron was examined to see if the corroded areas had any definite relation to these low points. Fair correspondence was obtained on one specimen, but others did not give definite results. These potentials are very difficult to locate, but it is probable they aid in starting local actions on the iron surface, producing red rust in small amount. This is electronegative, and action then becomes definite, and pitting proceeds.

A special corrosion cell was used to duplicate conditions of underground structures for further experiments on auto-electrolysis measurements. Three-inch bituminized fiber conduit was cut in sections about 3 in. long and filled with soil, in which was placed the iron plate. Sheet rubber disks placed in the ends made them air- and moisture-tight, and paraffined wooden disks over these completed the cell. With this arrangement, the specimen could be subjected to pressure. Sets were made up to determine the effects of different pressures and temperatures encountered in practice.

Corrosion of Lead

Lead, having a very low solution tension, is not so susceptible to auto-electrolysis as is iron. External conditions will produce corrosion, however, in a somewhat different manner. If two soils are in contact with a metal, one of which contains a substance subject to a change of valence, we may expect an electrical current flow. This current will enter the metal as part of its circuit, and leave it again, in the near proximity of the bi-electrolytic soil, causing corrosion of the cathode areas. Examples of lead corrosion of this type are given in a paper by E. H. Schofield, Minneapolis, Minn., and the writer, *Electric Railway Journal*, 1914, p. 1092.

Lead is also liable to corrosion from other conditions. Pipes leaving moist cement floors often corrode near the floor line. Cable covers lying in cement ducts and lead pipes in mortar walls are also destroyed. If water from condensation or other sources is allowed to collect or run down or around a lead structure under conditions when soluble salts are present, there will be formed a concentration cell. The electromotive force set up is caused by different velocities of different ions, which would be found in any surroundings of a pipe in cement or soil. The more dilute solution would be the fresh moisture supply; the more concentrated solution would be near the metal surface in the surrounding medium. Common specific instances of this type of corrosive action are seen at the bases of iron poles at the ground line. It occurs also if the pole is set in cement. This is a plausible explanation of the corrosion of the lead cable covers at Havana, previously mentioned. The bottom side of the cover lay in silt, electrolytically more concentrated. The dilute solution would be from condensation and the water flowing intermittently in the conduit, in contact with the upper surface of the lead.

The complete report of this investigation necessarily carries much detail which need not be included in this review. Tests on approximately 150 soil samples collected in the different cities mentioned, and the fact that many types of iron and lead specimens were treated in these soils, will give an idea of the scope of the work. Some representative results are given in Tables I and II. The influence of the moisture content of clays is shown in the chart, but this also shows that the electrolytic nature is variable in the different clays. Analyses of several soils were made, and it was found that the combined sulphates and chlorides had the greater influence in increasing corrosion. Although the amounts of these components are small in an average soil, and perhaps not over 0.5 per cent in the most active clays, yet their action is remittent and continuous, and corrosion proceeds without renewing the supply of acid ions.

TABLE I. ANALYSES OF IRONS.

No.	1 Per Cent	3 Per Cent	4 Per Cent	5 Per Cent	6 Per Cent	7 Per C.
Graphitic Carbon..	....	....	....	2.20	3.23	....
Combined Carbon ..	....	....	....	.73	.41	....
Total Carbon.....	0.02	0.200	0.060	2.93	3.64	0.153
Si.....	.003	.003	tr.	3.070	1.62	....
S.....	.005	.041	.019	.051	.133	....
Mn.....	.011	.432	.365	.283	.324	....
P.....	.000	.010	.027	.500	.458	....
Cu.....	.000	.170	.000	tr.	tr.	.233

1. Pure ingot iron No. 16 sheet.
3. No. 16 sheet.
4. No. 22 sheet.
5. From 6-in. cast iron pipe.
6. Cast iron, cast in ½ x ⅛ in. strips, broken 2 in. long, for test in soils.
7. No. 20 sheet.

An engineering crime often committed is that of placing iron pipes in cinders. Cinders have carbon particles, sulphates, and carry much moisture. This furnishes a most excellent example for illustration of the electrolytic theory of corrosion, as there is at once formed numerous localized electric batteries, where the iron is the positive and corroded element, carbon the electronegative pole, and the sulphates dissociate and form a very active electrolyte. As a result, the iron pipe is certain to leak, sometimes within a year.

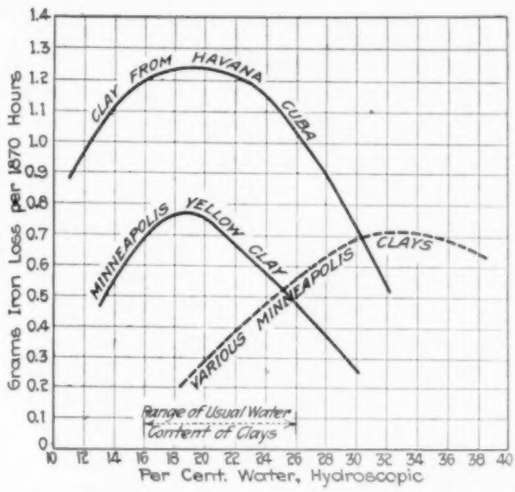

CHART SHOWING VARIATION OF AUTO-ELECTROLYSIS WITH MOISTURE CONTENT OF SOILS

Solid lines for cast iron No. 6. Broken line for both scaled and clean steel No. 3.

Conclusions

Some other conclusions derived from these experiments may be stated as follows:

Electrolysis of underground structures may be caused

by certain definite conditions, which may be determined by electrical measurements and a study of the environments.

The electrolytic theory is applicable to corrosion of underground iron and lead structures.

In comparing the corrosive resistance of different types of irons and steels, a careful study should be made of the conditions under which the metals are to be used, and tests conducted under these conditions. Conclusions should not be based on a few experiments, but many tests should be conducted and studied. A good factor for comparison is the "corrosion rate per unit area corroded per year." This factor varies with different metals and with different external conditions, as shown in Table II. Iron specimens should be treated at least 400 hours or longer if possible. The moisture content of the soils in the cell should be maintained constant. The corroded areas usually are definite on the cleaned test plate and may be measured by planimeter.

From experiments performed, and corrosion rates found, the probable life of an iron structure in given soils may be predetermined. The weight of ½-in. iron 1 sq.in. in area is 15.8 g. Assuming corrosion forms

TABLE II. IRON LOST FROM CORROSIVE ACTION OF NATURAL SOILS

Soils	Cast Iron (Anal. 6) As Cast A	Cast Iron (Anal. 6) As Cast B	Cast Iron (Anal. 6) Polished A	Cast Iron (Anal. 6) Polished B	Mild Steel (Anal. 3) With Mill Scale A	Mild Steel (Anal. 3) With Mill Scale B	Mild Steel (Anal. 3) Polished A	Mild Steel (Anal. 3) Polished B	99.94% (Anal. 1) Ingot Iron Sheet A	99.94% (Anal. 1) Ingot Iron Polished B
Clay 21.5% water	2.02	1.18	1.36	0.90	0.83 1.17	0.41 0.51	0.992	0.34	0.47	0.12
Black Peat 39.4% Water	2.75	1.05	3.44	2.65	2.22 1.70	2.47 0.57	2.82	1.76	2.82	1.47
Mixed 27.8% Water	1.48 1.34	1.18 0.64	2.41	1.60	1.29 0.84 1.06	0.807 0.45 0.59	1.69	0.70	1.17	0.47
Loam	1.51	0.66			0.97	0.52				
4" pipe in clay and black peat	171 171	5.18 5.18								

Column A, grams per year lost from plates; column B, grams lost per year per square inch of corroded area. Area of plates 4.8 to 5.5 sq.in. Plates underlined treated 1.07 years; all others 0.23 year. The 4-in. cast iron pipe, 41.5 in. long, was treated 0.85 year. Cells in glass beakers. Large pipe in wooden cell. Loss by water evaporation determined by weighing cells at intervals and replaced by adding pure water.

a conical pit, the metal removed weighs 5.2 g. Referring to Table III, the scaled mild steel specimen in clay showed a yearly corrosion rate per square inch of corroded area of 0.51 g. As $\frac{5.2}{0.51}$ is 10.0 years, this is the probable life of a mild steel black iron pipe with ½-in. wall, buried in an average moist clay soil.

The ordinary coatings, mill scale, poor grades of galvanizing, casting skin and tar dips on cast iron have little value as protection against auto-electrolysis, and in cases accelerate it. Tar dips lengthen the life of cast iron by delaying the action, but the coating will soon fail in spots.

The longer life of cast iron is due to its greater wall thickness.

Corrosion rates of iron are little affected by temperature changes within the range usually found about water pipes.

Corrosion rates are appreciably increased by pressures within the range of pressures met in practice due to depths of burial.

TABLE III. AUTO-ELECTROLYSIS IN DIFFERENT SOILS

Clay A, St. Paul	0.0198
Dark gray clay, Pierre, South Dakota	0.0613
Yellow clay, Indiana	0.0915
Light gray clay, Havana, Cuba	0.0295
Yellow clay, Havana, Cuba	0.3240
Blue clay, Minneapolis	0.0597
Peat D, St. Paul	0.2300

Ingot iron, analysis 1, 1.3x2.5-in. polished plates. Grams iron lost after treating 528 hours in fiber cells. Water content approximately the natural percentage.

Admitting or excluding air from a test cell has no appreciable effect on corrosion rates.

The life of underground iron structures could be greatly prolonged by placing a few inches of sand around them, especially in clay, cinders and moist electrolytically active soils.

Denver, Col.

Industrial Courts in Great Britain

In response to questions asked in Parliament on March 3, 1920, Sir Robert Horne, British Minister of Labor, stated that the Industrial Court established by the industrial courts act, which received the royal assent on Nov. 20, 1919, had been duly set up. The president of the court is Sir William MacKenzie, Violet Markham and Cecile Matheson representing the women.

The court is a standing arbitration tribunal, the provision of which was one of the recommendations of the Committee on Relations between Employers and Employees, better known as the Whitley Committee. It is the desire of the government that trade disputes should be settled as far as possible by negotiation between employers' associations and trade unions. In cases where agreement is impossible recourse can be had to the Industrial Court, provided consent of both parties to the dispute is forthcoming. One of the advantages of reference to a standing court is that the experience of the members of the court in dealing with difficulties in other trades is placed at the disposal of the parties to a particular dispute.

The Minister of Labor went on to say that since Nov. 20, 1919, 208 differences have been referred to the court. These have been heard mostly in London, but the court has also sat in Glasgow, Dublin, Belfast, Liverpool, Manchester, Sheffield, and elsewhere in its ordinary form, by which three members of the court—a chairman, a representative of the employers, and a representative of the employees—constitute the court, while a certain number of cases have been dealt with in different parts of the country by single members of the court. The differences have chiefly concerned questions of wages, but many other industrial matters have come before the court. The court has settled the general wage arrangements for the Scottish building trade, gas undertakings throughout Great Britain, the spelter trade, the clay industry, the bobbin and shuttle making industry, the seed-crushing and oil-milling industry, and the organ-building trade, and wages of women employed in railway shops.

The court has at present before it claims for national increases of wages in the engineering, shipbuilding, and explosives trades, together with the wages of railway shopmen. "As far as I am in a position to judge," Sir Robert concluded, "the court appears to have commended itself to both employers and employees. It is recognized to be an impartial and independent tribunal, and I think that it will continue to serve a most useful purpose in the national life."

A Comparative Test Upon High-Speed Steels—IV

Chemical Composition, Microstructure, and Manufacturing Methods Which Distinguish the Really Superior Brands—It Is Perfectly Feasible for the Metallurgist in the Smaller Shops to Determine the Tool Best Suited for His Requirements*

By A. J. LANGHAMMER, M.E.†

AFTER the test had been completed and the winners decided upon, there was still one point to be determined of fascinating interest from an industrial engineering standpoint.

Why did steels with an almost ideal chemical composition and good microstructure fail utterly? It was believed that an inspection tour of the various plants making tool steel would possibly shed some light on the matter. Happily, the writer was able to take this trip, and though it was impossible to visit all of the mills whose product was tested, due to limited time, yet a representative group was inspected. The principal points investigated were the organization, shop and laboratory equipment, personnel, plant laycut, manufacturing methods, inspection methods and the raw materials used.

Good High-Speed Steel Is Strictly a Quality Product

Coming into the steel plants in this manner with a fresh viewpoint and having access to all departments, it was relatively easy to detect deficiencies or, better still, to ascertain why some brands simply *had to be* of superior quality. A well-balanced organization, modern, high-grade equipment, properly planned and executed work, experienced and careful workmen, together with the best only of raw materials and expert supervision, cannot help but be reflected in the product. Then, too, there are elements of refinement (analogous in a way to that of polishing and buffing the domes of cylinder heads on a very high-grade motor) that some steel manufacturers do not incorporate in their product. As a matter of fact, whenever the policy was such that everything was sacrificed for quality and no product except such as met the established standard was shipped, an excellent steel was produced.

The above-stated general conditions are, of course, essential in the manufacture of a good steel. It is felt, however, that there are some additional important factors that will bear special mention, and for this reason they are listed below.

Raw Materials

A good iron as basic material is invaluable. Especially is this apparent where the refinement of the iron is controlled by the tool steel mill. The same is of course true of the other alloys, though in this case there are relatively few mills that control the production of the bulk of their raw metal. This latter feature is very desirable, especially when a market scarcity exists in the rarer elements. The chemical composition of the iron, both before and after refinement, should be held to close limits and frequent examinations made for the presence of slag and other inclusions.

Melting

Furnace construction and condition, grade of crucibles, correct mixture and temperature control are vital factors in melting practice. In pouring, the best practice is to eliminate the ladle and pour the ingot direct from individual crucibles. Each ingot, then, after annealing, should be analyzed and graded. If a steel mill makes various grades, it thereby effects quite a saving in costs over the "one-grade mill." Rigid inspection for surface defects should follow naturally.

Forging

Uniformly slow pre-heating and accurate temperature control for the forging operation are essential. Hammers of sufficient size or capacity should be used and in the same way the ingot must be of large enough cross-section to permit a sufficient reduction in area. When an ingot is worked in the rolling mills, the various factors must be controlled and a high standard set. Subsequent chipping or grinding is then followed by another inspection.

Miscellaneous

In the mixing of the alloy, especially where the electric furnace is used, there is an excellent opportunity for the introduction of "elixirs" (if that term may be used) such as uranium, and quite a bit of work is being done to this end. An advantage that few modern high-speed steels possess in any marked degree is that of being able to withstand the high heat in hardening without scaling. Needless to say, this is of prime importance in the manufacture of taps, hobs, form tools, etc., especially where the hardening is done in an open fire and not by packing.

Discussion of Results

Perhaps the most interesting data of the whole test are those presented on the two graph sheets, Figs. 5 and 6, reproduced herewith. Quite a few factors are brought out clearly, two of which appear of extreme importance, and which should be classed as essential requisites when a test of this nature is planned. They are the *number of specimen tools* used per brand and the *time limit in which failure should occur*. By an inspection of the graphs, it is at once obvious that no two tools of any one brand (of the same bar, heat treatment and subjected to identical working conditions) gave the same results. In most cases a wide variation is found, indicating that at least four and possibly six tools must be used if the results of a test are to be reliable. It is

*For Parts I, II and III, see CHEM. & MET. ENG., vol. 22, Nos. 18, 19 and 20, May 5, 12 and 19, pp. 829, 889, and 939.

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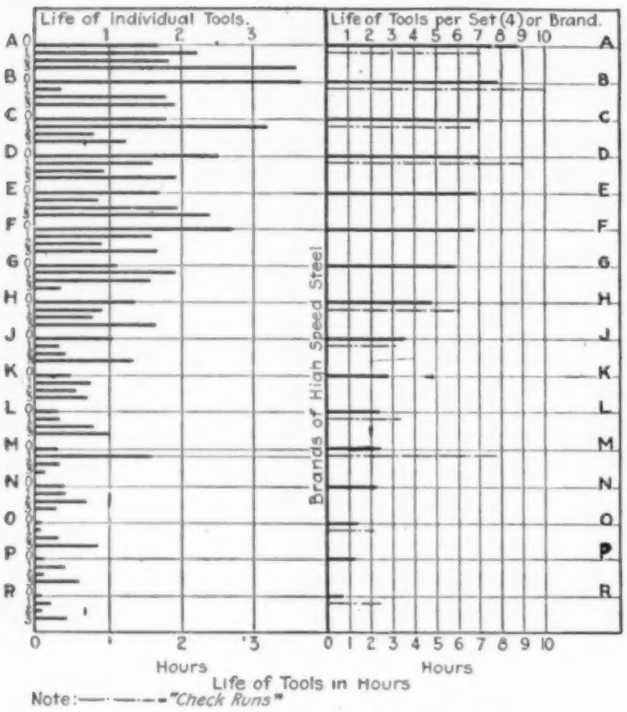


FIG. 5. CURVE SHEET OF FIRST RUN

Turning Liberty motor cylinders 5¼ in. diameter. Tool with ¼-in. radius nose; cutting speed, 35 ft.; feed, 0.054 in.; depth, ⅜ in.

felt that this is a point of great importance, because conclusions are often based on the performance of one tool only and the above results indicate that such a test really means very little. When but one tool is used, the results may flatter a brand or do it great injustice with equal equanimity and in either case the consumer is the loser. The steel company, too, in such an instance does not have the proper opportunity to show the quality of its product.

The other point of importance brought out in the graphs is that apparently when a tool is not forced or put to heavy duty, a mediocre steel may show up almost as well as a good brand. As the average plant probably does not exact a high duty from the high-speed tools in use, this fact explains why an inferior or even a poor brand may give fairly satisfactory results. Attention is invited to the fact that a superior steel will demonstrate its worth regardless of the duty exacted. For example, see steel B and D in both graphs. In the first run it will be remembered the cutting speed was 35 ft., the depth of cut ⅜ in. and the feed 0.054 in., while in the second run the other factors remained the same except that the feed was increased to 0.090 in. A steel which is less excellent but still may be classed as "good" does not always fare so well, as is shown, for instance, by brand K. At this point it will probably be well to consider the exactly opposite performance of brand A, which finished as the leader in the first run, and in only the sixth position in the second run.

In the heat-treatment chart it will be noticed that this steel was treated with cyanide while at the high heat, the resulting "case" probably aiding the steel materially in the first run. After failing while cutting and then being reground (the case being removed in grinding) the beneficial effect of the case hardening was removed and the steel was graded as "good" steel only and not as a "superior" brand. While it appears that the cyanide treatment possibly aids a tool to some extent, its application should not be encouraged because it provides for non-uniformity, causes gasification and gives off dense, obnoxious fumes at the high heat, and distracts the attention of the tool hardener to a most undesirable extent. It is also to be noticed, from an examination of Table IV, page 941, that the nose of tool number 1 of brand B broke during the first run, thereby preventing this brand from finishing as the leader in this run also, to which position it unquestionably is entitled.

Check Runs

Attention is directed to the "check runs" indicated on both graphs. These additional runs were conducted to check the results of the leaders primarily, but as long as a check run was being made it was decided to include some of the other brands where the possibility of accidental performance such as broken tools indicated that they might be entitled to a higher standing. Steels of exceptionally promising analysis were also included in the check run. On every case a different bar of steel was procured from a standard supply; tools were then made up and put through the test like the first batch. It is to be noticed that the sequence as established by the original runs was not altered except in the case of brand M, which steel moved up to third position. This was to be expected because experience with brands C and J, previously occupying that position in the first and second runs respectively, had indicated that both steels were very non-uniform. Besides, they gave a lot of trouble in hardening. The rest of the check runs resulted in relatively unimportant changes in standing except that in nearly every case the "life" was greater than that of the original results. This fact seemed to indicate that brands D and B would at least duplicate the performance exhibited during the test

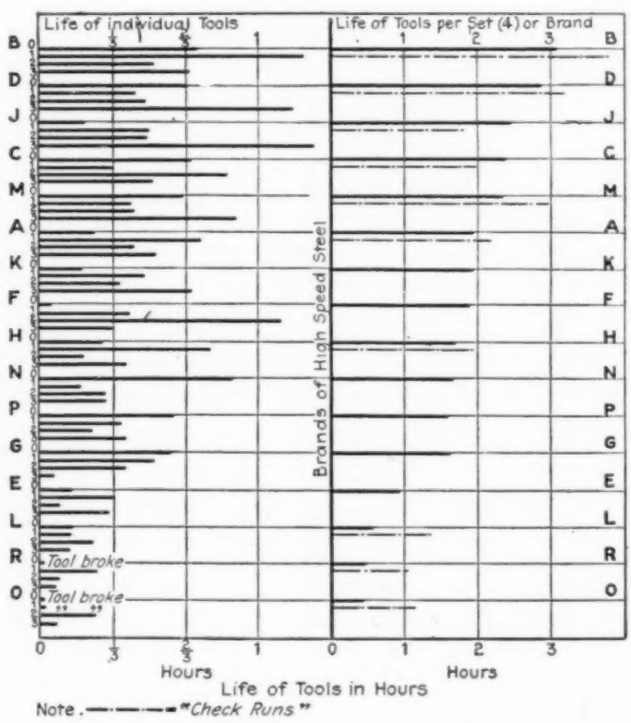


FIG. 6. CURVE SHEET OF SECOND RUN

Turning Liberty motor cylinders 5¼ in. diameter. Tool with ¼-in. radius nose; cutting speed, 35 ft.; feed, 0.090 in.; depth, ⅜ in.

at any time and probably would average even better. Brand M, on the other hand, showed a marked improvement in the check run, in which feature it far surpassed brands J and C and was awarded third place for this reason.

It is to be noted that one of these two "superior" steels, i.e., D and B, was in use at the Packard factory previous to the test. As a matter of fact the particular brand in question had been adopted as the factory standard for all Packard-made cutting tools. It should be further emphasized that unlike many large factories, tool steels are here specified by the mechanical department—which department is solely responsible for all machine and tool equipment used in the plant—rather than the purchasing department. This condition reflects credit on the head of the manufacturing department and his staff from the standpoint of industrial engineering.

Comparative Ratings by Other Large Consumers

It was thought expedient about this time to compare these results with those obtained by other large manufacturers. In Table VIII are given data collected with this end in view, the notation in each case being identical with the same symbols as were used in the test. The firms represented are composed of six large automotive manufacturers and three important tool companies. It will be noticed that three of the eight concerns represented buy their steel on the basis of results shown in actual test runs, one company on the basis of analysis only, and the four others on the basis of popular opinion. Note the fact that in the three cases where a cutting test was conducted, brand B was the winner. Further, in one of these instances brands M and D finished second and third respectively; in another, brand D was second and M fourth; while in the third case no mention is made of the other brands, besides B, that were in the test. These data were much appreciated because they verified the findings given in the Packard test to determine the correct choice of really superior steels and also presented some interesting facts about the brands as a whole.

Costs as Affected by a Superior Brand of Tool Steel

Automobile manufacturers usually make but a small percentage of the cutting tools required in their plant. Whenever possible, a standard tool is used, for example milling cutters, end mills, counterbores, hollow mills, reamers, taps, dies, twist drills, etc., and these are secured from companies which specialize in their manufacture. In the same way there are concerns which specialize in the manufacture of special cutting tools, and they in turn satisfy the requirements of the automobile manufacturer. This distribution then obviously effects the greatest economy that can be achieved and also tends to make a uniformly good product. However, some tools must always be made in an automobile manufacturer's own plant, and the annual cost of high-speed steel for this purpose (as it comes from the steel mills) in a factory employing 10,000 men is about $125,000. A plant employing 20,000 men requires about $250,000 worth of high-speed steel, and larger or smaller factories are affected in the same proportion. The cost of the finished tools made from the first amount of steel ($125,000 worth) would be approximately $375,000.

So far, though, these figures show only relative values of the tools. As pointed out in a foregoing paragraph, the tool made from a poor steel may break during hardening, or if it gets into the machine shop it will then give extremely poor results in performance. During rush periods, assuming no excess finished goods in stock, such tool trouble, when occurring on major units like cylinders, crankcases or crankshafts, means that just so many less motors or finished cars can be shipped on that day and production cost is increased accordingly. All of these costs, however, are chargeable to the poor quality of high-speed steel that has been used. It is difficult to say to just what extent manufacturing costs will be affected, but aside entirely from the losses in indirect labor, material and burden that occur when a finished tool of poor steel breaks in hardening, the writer feels that a superior high-speed steel will easily decrease the direct labor cost from 5 to 10 per cent.

TABLE VIII.

Brands of high-speed steel being used by six large automotive manufacturers and three tool companies, and the sequence of their rating in each case.

Name of Co. or Manufacturer	Brands Being Used	Brands "Tried"	First Choice	Brands in Sequence of Desirability	Undesirable	Remarks
a	B H A J R D M	B C H N A O R D M	B	B D H M A J R	None	These classifications are the results of an actual cutting test.
b	R G B C	R,O G B C,N	R	Non-committal	N O	No test had been conducted in years.
d	B C	B C	B	B	None	In a test recently completed, B proved superior to all others and will be used exclusively.
e	J L C W	J L C W	J, W & L	Non-committal	None	All high speed steel is bought on the basis of analysis.
f	F J L B C	F J,H L,X F,H C	Non-committal	Non-committal	H N X*	Analysis is specified but used as an indicator only.
g	D B H M R Y*	D,Y B,J H M,C R,O N	B	B M D H Y* R	C O N J	Standard analysis as specified by the steel maker is required. Classification is made on the basis of actual cutting tests.
h	C N D A	C N D H	A and H	Non-committal	None	Classification based on opinion only.
j	F O N M	F N O M	Non-committal	Non-committal	None	No test had been conducted for five years.
m	C N O R	C N O R	C and N	C N O R	None	Classification based on what the men of the manufacturing department "thought" about the brand.

*X and Y are brands of steel that were not represented in the test; they are obviously of inferior quality.

To give a better perspective of the cost and number of tools required to carry out a gasoline motor manufacturing program, the following figures are quoted from the text book of lectures used in the "Advanced Training School"[1] of the Packard Motor Car Co.:

"The total number of tools made by the Packard Motor Car Co. for the Liberty '12' airplane motor was 1,796,910. The cost of the perishable tools only was $1,466,540. Standard tools, such as drills, reamers, counterbores, taps and dies, cost approximately $500,000.

"We used 48,000 special tools for machining the connecting rods, 42,862 of which were perishable tools. For the large cutters which were used for straddle

[1]Edited by D. G. Stanbrough, general superintendent, Packard Motor Car Co.

TABLE II. COMPOSITION AND HEAT TREATMENTS OF TOOL STEELS TESTED

	Chemical Composition *							Heat Treatment				
Brand	Carbon	Tungsten	Vanadium	Nickel	Chromium	Cobalt	Uranium	Preheating	Hardening	Quenching Medium	Drawing Temperature	Remarks on Heat Treatment
A	0.79	12.8	1.74	0.10	3.78	None	None	All tools slowly preheated to 1550-1600 F.	The temperature in the hardening furnace was maintained at practically 2300 F. The tools were withdrawn and quenched when the condition of sweating was satisfactory to the expert representing the steel company which produced the brand being hardened.	Oil	1050	Cyanide on tip of tools during hardening.
B	0.64	16.9	0.92	0.10	2.42	None	None			Lead at 1050 F.	1100	"B" tools withstood the high heat very well.
C	0.40	18.00	0.51	Tr.	3.53	None	0.11			Lead and kerosene.	1050	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in kerosene.
D	0.62	14.86	1.05	Tr.	3.59	None	0.10			Lead at 1050 F.	1100	One-half of tool immersed in lead. Relatively short heat.
E	0.49	17.35	0.23	Tr.	2.78	None	0.14			Lead	1100	
F †	0.67	19.70	0.99	0.21	3.78	None	None			Oil and lead	1100	Tools 0 and 1 quenched in lead. Tools 2 and 3 quenched in oil.
..	0.65	15.79	0.49	0.24	3.44	None	None			.....	.....	
G	0.62	18.26	0.75	Tr.	3.70	None	None			Oil	1050	
H	0.66	18.30	0.45	None	4.17	None	None			Lead at 1050 F.	1075	
J	0.68	18.12	0.48	Tr.	2.63	None	0.10			Oil and lead	1050	Tools 0 and 3 were immersed half way in oil; then they were placed on the floor and thus drawn.
K	0.59	13.34	0.95	Tr.	3.64	None	0.15			Oil	1075	
L	0.76	21.92	1.05	None	5.27	None	None			Lead at 1050 F.	1050	
M	0.69	16.95	0.75	0.18	3.09	None	None			Oil and kerosene	1100	Tool 2 quenched in oil. Tools 0, 1 and 3 quenched in kerosene. "M" tools withstood the high heat very well.
N	0.66	13.55	2.20	0.10	3.59	None	None			Oil	1050	
O	0.67	13.50	0.99	0.20	4.30	None	None			Oil and lead	1100	For tool 0 only. Tools 1, 2 and 3 were not drawn.
P	0.38	15.27	0.05	0.20	2.85	None	0.14			Lead	1100	Blistered on heating.
R	0.65	17.08	0.58	0.20	2.78	None	0.10			Oil and lead	1075	Tools 0 and 2 were quenched in lead. Tools 1 and 3 were quenched in oil.
										.....	.....	
13, 14‡	0.75	11.12	2.10	0.32	5.13	None	None					

The samples for chemical analysis were obtained from the same section of the bar of which the tools were made.

The temperature of the lead bath used in quenching was maintained at a temperature of 105 F. The tools were immersed in the molten metal for about 3 min., and then allowed to cool in the air.

* Phosphorus and sulphur below 0.04 per cent in all cases.
† The second analysis under F gives that of a second bar obtained subsequently.
‡ This steel was not tested, but its microstructure is shown in Figs. 13 and 14.

milling the large ends of the connecting rods, there were 25,000 cutter blades costing $4 each. Eighteen hundred end mills were used for milling out the channel of the rod, and 4,100 doming tools for the cylinder."

It will be observed that the total cost of special and standard cutting tools required for producing the Liberty motor at the Packard Motor Car Co. was $2,000,000 in round figures. One item alone, that of the cutter blades for straddle milling the large ends of the connecting rods, cost $100,000. The tremendous importance of using only the cream of superior grades of high-speed steel is, then, readily perceived, but we must not forget that these figures involve only indirect factory costs. As was pointed out repeatedly, the real inefficiency is not reflected in the tool costs but in the direct labor costs and in a degree far in excess of that indicated by the above figures.

Preferred Chemical Analysis

About the first factor usually determined when a test is to be conducted on a large scale is that of the chemical composition of the different brands. By an inspection of Table II reproduced herewith an astonishing and entirely unwarranted variation of the proportion of the elements well known today as requisite is disclosed. The carbon content varies from 0.38 to 0.79, tungsten from 12.8 to 21.92, vanadium from 0.05 to 2.20, chromium from 2.72 to 5.27. Phosphorus and sulphur were below 0.04 in all cases, while other elements were present in practically a "trace" only. Uranium was probably present in an appreciable quantity in brand D only, the other traces being due to difficultly separated impurities. It is to be noticed that no cobalt or molybdenum was used by any of the steel makers whose brand was represented in the test.

Quite a variation will be observed in the heat treatment of these tools. Table II also contains the details of the heat treatment and such notes on observations as were made. It will be observed that some of the tools of the same brand were treated differently, though this applied only to the kind of quenching medium used and variations in the drawing temperature. On the whole, however, such practice indicates an apparent uncertainty on the part of the steel makers as to which treatment is the best for general purposes or even for a specific requirement.

Regarding the desired chemical composition, the writer feels that the following analysis is probably the most desirable for modern high-speed steel. Alongside is also affixed the analysis of the best high-speed steel tested by Frederick W. Taylor when he wrote his classical monograph "On the Art of Cutting Metals." It shows that this master has apparently plumbed the depth of the art, so that the last fifteen years show little progress in new compositions. As a matter of fact, Taylor recommended an ideal composition, slightly different from the one listed as giving him the best results.

	Minimum	Maximum	Taylor's Best Steel
Carbon	0.62	0.68	0.67
Tungsten	17.00	18.20	18.0
Vanadium	0.85	1.05	0.29
Chromium	3.00	4.50	5.5
Silicon	0.20	0.30	0.04
Phosphorus	0.00	0.04	Low
Sulphur	0.00	0.04	Low
Other impurities	0.00	0.10	
Manganese	0.00	0.00	0.11

Of course, were a substituting element such as molybdenum, uranium or cobalt used, the composition will be varied accordingly.

Microstructure of Annealed Steels

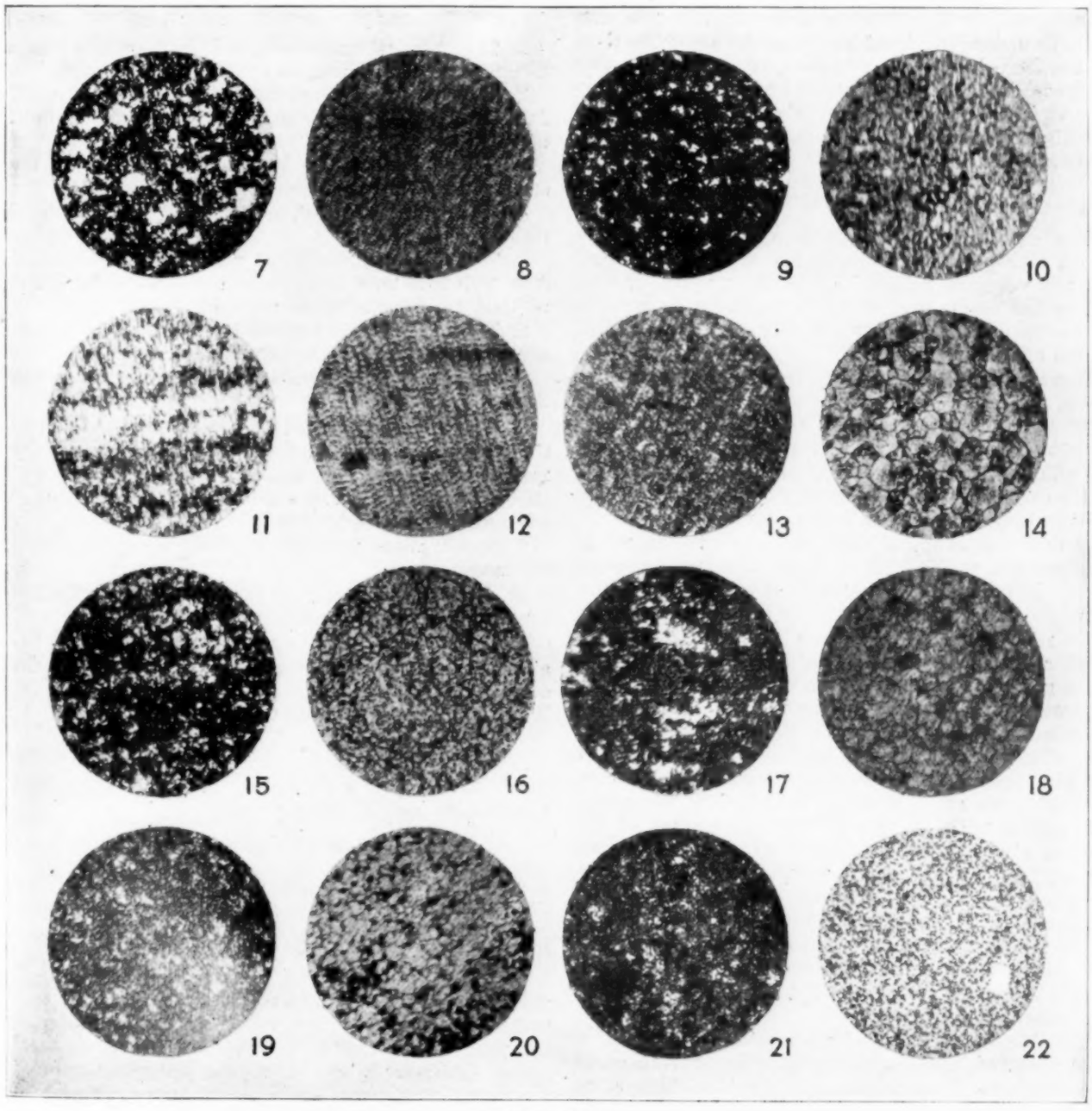
In order to determine the variation that might exist in the microstructure of the various brands of high-speed steel used in the test, specimens were examined

both in the condition in which they were received and also after hardening. It is understood, of course, that these specimens were made from the same section of the bar as were the test tools proper. The hardening of the samples used for microscopic examination was performed by an expert workman of wide experience in the hardening of high-speed steel. In every case the hardening specifications as quoted by the steel manufacturer were used. None of the samples was drawn, because it was desired only to investigate the structure resulting from the prescribed treatment at the high temperature.

Photomicrographs depicting the structure of seven different brands (both in the annealed state as received from the mills and after hardening) are shown in Figs. 7 to 22, all at 100 diameters.

In the case of brand F four exposures, 7 to 10, include a second pair made from a short piece cut from a bar secured from a different source. The set of pictures, as well as the analysis, Table II, shows clearly the wide variations that may be met in this brand.

An inspection of the odd-numbered microphotographs, showing the steel as it came from the mills, indicates that it was all in an annealed state; no trace is exhibited in any of the specimens of the original cellular ingot structure found in the newer cast high-speed steel. The microstructure therefore shows the presence of free carbides bedded in a sorbitic matrix. However, the quantity and the distribution of the carbides differ greatly in the various brands. The amount of free carbides, of course, depends on the composition and the rate of cooling. In the following brief discussion only the general characteristics exhibited in the different microphotographs will be noted.



FIGS. 7 TO 22

Microstructure at 100 diameters after nitric acid etching of some typical high-speed steels. Odd numbers are steels as received; even numbers the corresponding steels after hardening. Figs. 7, 8, 9 and 10 are of brand F; Figs. 11 and 12, brand L; Figs. 13 and 14, brand O, low W; Figs. 15 and 16, brand O; Figs. 17 and 18, brand B; Figs. 19 and 20, brand N, Figs. 21 and 22, brand H

Figs. 7 and 9, as remarked above, are of one brand (F) and therefore probably underwent the same cooling. However, the quantity of free carbides shown in Fig. 7 is much higher than that in Fig. 9. This difference is explained by the higher percentage of tungsten in the former case. In Fig. 11 it will be seen that the carbides are most conspicuous and the chemical analysis (brand L) shows the tungsten in this instance to be the highest of all steels tested. Again in Fig. 13, a bar of brand O in which the tungsten dropped to 11.12 per cent, little free carbide is found. Several of the specimens having good percentages of carbon and tungsten do not reveal corresponding amounts of the free carbides. Probably in such instances the rate of cooling was faster or perhaps the time at the annealing temperature was shorter.

In several instances the distribution of carbides is found to be quite non-uniform. This is brought out exceptionally well in Fig. 11 and Fig. 15. The carbides as depicted in these two cases are obviously more or less segregated into striations, whch indicates that the annealing was not sufficiently prolonged. An inspection of Fig. 12 discloses that even after hardening at the high temperature, this marked segregation of carbides still persists.

Microstructure of Hardened Steels

The exact nature of the physicochemical changes which take place in the hardening of high-speed steel are not yet fully known. Up to the present time no theory has been advanced which satisfactorily explains all the phenomena exhibited by the heating and cooling curves of this steel.[2]

However, it is known that for the best results in hardening, two requirements should be fulfilled. One of the requisites is that the carbides must first be taken into solution and then held in that state by a proper rate of cooling. The second requirement is that the solution of the carbides should be effected in such a manner that the resulting grain size is held to a minimum.

In carbon steel and in most alloy steels the preceding requirements are fulfilled at nearly the same temperatures. In other words, the carbides go into solution at about the same temperature, which also gives maximum grain refinement. This, however, is not true in high-speed steel. Here the temperature at which the carbides go into solution is far above the grain-refining temperature. Since both temperature and time are functions of the grain size, it is imperative that the tool, after thorough pre-heating, be brought rapidly to the high heat and held there for a minimum of time. Otherwise the grain structure will become too coarse and brittle, with consequent fragility. Some of the alloying elements in high-speed steel, tungsten in particular, tend to make grain growth more difficult, an influence on the grain size very beneficial to steel requiring high hardening temperature. On considering the variables which enter into the hardening process, and the difficulty with which they are controlled, the folly of drawing conclusions from tests made with a single tool is evident.

Examination of the photomicrographs of the hardened specimen shows quite a variation in the grain size. In most instances the nitric acid etching after hardening reveals polyhedral structure, part austenitic, part martensitic. The specimen shown in Fig. 14 shows the largest grain structure. Although the granulation in this instance is large as compared to some of the other specimens shown, still it is not uncommonly met with in commercial hardening. Perhaps in this case the large grain size was occasioned more by the high carbon and the low tungsten than by the temperature and time.

The microstructure of the hardened samples shows that little of the free carbides remained undissolved. Only in Figs. 10 and 14 are appreciable quantities of the carbides to be seen. Moderate amounts of undissolved carbide are believed not to have a detrimental effect on the cutting properties providing the tungsten and chromium contents are normal. Still, when the amount of the carbides is too great, as in Fig. 14, the solution will not be sufficiently complete to give good results.

Facts Brought Out in the Test

1. The chemical analysis of a high-speed steel may be used only as an indicator of its possible qualities.
2. Tools made of a medium grade of steel will work fairly satisfactorily when subjected to a relatively light duty.
3. No two tools of the same brand give exactly the same results, in a cutting test.
4. In conducting a test, no less than four specimen tools should be used.
5. To get the most efficient results from high-speed steel tools they must be operated under heavy duty, and no tests are reliable unless made with heavy cuts.
6. Test tools must be reground once, at least, and then again put through another run.
7. High-speed steel should be purchased only on the basis of performance.
8. A wide variation exists in the cutting qualities of the various brands of high-speed steel that are on the market today, and both indirect (material, labor and burden) and direct (labor and burden) costs are affected adversely when inferior steels are used.
9. Heat-treating practices of today leave wide room for improvement.
10. In hardening, the time factor is probably the important item needing investigation.
11. It is expected that a method of determining the efficiency of high-speed steel by means other than the service cutting test will be developed. Work with the X-ray and magnetic properties are quite hopeful in this direction.
12. It is believed that today the American manufacturers can produce a high-speed steel that is at least equal to the best European brands.

Application to the Small Shop

As was pointed out in the opening paragraph of this article, the proper choice of high-speed steel brands is of equal importance to the large manufacturer and the small shop. The writer is convinced that the time is not far distant when even the largest manufacturers will not only use a superior brand for the tools they make themselves but they will, in addition, prescribe the particular brand or a series of brands to "tool shops" that must be used in all the tools manufactured for them. This would apply to standard tools such as milling cutters, counterbores and twist drills, as well as for cutting tools of special design.

All tool steel will be specified by the mechanical

[2]See Sauveur, "Metallography and Heat Treatment."

superintendent, and the purchasing department will work in close co-ordination with that office. It naturally follows that a steel salesman with mechanical training and wide practical experience in manufacturing and steel making will be the successful salesman of the immediate future.

Now, then, what about the small machine shop? Obviously, such an institution cannot conduct a test in the elaborate manner described above. It can, however, conduct a thorough test in a small way, and the following suggestions may be helpful:

Some investigators have apparently concluded that a cutting test consisting of running a tool to destruction by "turning off the face" (that is to say, using the cross-feed and not longitudinal feed) of a bar yields accurate results. This, in my opinion, is erroneous. In the first place, at least two variables are introduced—cutting speed and material cut. It will easily be appreciated that under the proposed conditions the cutting speed varies so that at the center of the bar the duty is very low; as the periphery is approached it increases rapidly to an abnormal value. Now, if a tool approaches its breaking-down point while cutting anywhere near the periphery, failure occurs at once. If, on the other hand, a "weary" tool escapes failure at the periphery, it will continue to cut on its next travel out from the center until a high cutting speed is reached, when it will fail suddenly. However, had the previous cut been continued for a short time longer, possibly seconds only, failure would have inevitably occurred. The total life in such a case will vary widely, giving results entirely out of proportion to the facts. Variations in the material cut will also be encountered, as absolute homogeneity cannot be obtained for any great depth. There are other objections of a practical nature, but it is felt the above are sufficient to establish my positions.

The brands used in the small test can be of a limited number, therefore time spent in investigating a product before it is granted entry to the group to be tested is well spent indeed. Usually, two letters of inquiry per brand will be sufficient to classify it definitely. These letters would naturally be addressed to prominent users of high-speed steel who base their choice of brands on the results of actual cutting tests.

A thorough understanding of Taylor's thirteen fundamental variables and important factors brought out in this work, together with proper safeguarding of the human element, is, of course, essential. Stringent means must be employed to insure the correct heat treatment, and to avoid possible damage in hardening. As far as the material is concerned, a straight production job will give entire satisfaction so long as the necessary precautions are taken. A feed of $\frac{1}{16}$ in. or more, depth of cut $\frac{1}{4}$ in. or greater, time for failure of tool to occur twenty minutes to one-half hour, four test tools per brand, provision for at least one regrind, and a reliable record of all the data will round out the requirements. Finally, as much information as possible should be secured from reliable disinterested parties concerning the various brands of high-speed steel on the market.

APPRECIATION

It affords the writer particular pleasure to acknowledge his appreciation of the great assistance of his present and former associates, R. N. Brown, J. J. Long, E. P. Stenger, F. R. Weaver and M. Y. Kaptansky, who have contributed so much of value to this work.

Canada's Productive Power

The productive power of Canada during 1919 was greater than at any previous time in the history of the country, being in excess of $5,000,000,000, or approximately double that of five or six years ago. This total is made up of:

Manufactured goods	$3,015,506,000
Field crops	1,452,787,000
Live stock sold or slaughtered	250,000,000
Milk and dairy butter	165,000,000
Eggs	50,000,000
Fruits and vegetables	50,000,000
Wool	12,000,000
Fisheries	58,000,000
Forest products	175,000,000
Mining	167,000,000

The figures regarding the manufacturing industry are based upon the census covering 1917 and are in all probability under rather than over the mark as applied to current conditions, there having since then been substantial expansion in several branches of the industry. This is particularly true of such important industries as paper and pulp, automobiles, iron and steel, furniture, and textiles. There is also the shipbuilding industry, which has greatly expanded since 1917, as seen from the shipping report issued in the month of March by the Dominion Government, which shows that during the fiscal year 1919 the aggregate tonnage of the vessels built was 104,444 tons compared with 28,638 two years before.

The figures covering field crops, wool, fisheries, mining, and forest products are compiled from various official government returns. Those covering live stock, milk, dairy butter, eggs, fruits, and vegetables are based on the last regular census returns, with conservative estimated allowances for appreciation in market values. The factory output of butter and cheese or of condensed cream, milk, and powder is included under the classification of manufactured goods. Cheese and butter made in the factories of the Dominion now have an annual value, according to the figures of the Statistical Bureau at Ottawa, of $81,657,000, an increase of nearly $6,000,000, compared with 1917; while the output of condensed and evaporated milk and milk powder, as a result of the enormous expansion which has taken place during the last year or two, was recently estimated by the Dairy Commissioner to possess an annual value of $22,000,000.

Development of French Chemical Industries

The figures below give some idea of the increase in the productive capacity of France during the war in chemical substances other than fine chemicals. They are quoted from the *Board of Trade Journal* for April 1, 1920.

	1913		1919	
Products	Production, Tons	Consumption, Tons	Production, Tons	Consumption, Tons
Sulphuric acid, 58 deg.	1,160,000	1,172,500	2,500,000	1,500,000
Sulphuric acid, 66 deg.	58,000	58,000	1,200,000	.....
Oleum (fuming sulphuric acid)	6,000	6,000	300,000	25,000
Nitric acid	20,000	18,500	360,000	20,000
Sodium salts	625,500	506,000	800,000	650,000
Liquid chlorine	300	.....	90,000	15,000
Bromine	.....	100	500	200
Calcium carbide	32,000	28,000	200,000	.....
Calcium cyanamide	7,500	8,000	300,000	.....
Ammonium salts	75,000	95,000	200,000	150,000
Nitrate of lime	.....	9,500	250,000	250,000
Natural phosphates	2,700,000	1,220,000	3,000,000	2,700,000
Superphosphates	1,965,000	1,900,000	2,500,000	2,500,000
Phosphorus	300	30	3,600	.....

Great strides, the *Journal* states, have also been made in the manufacture of synthetic products, an impetus having been given by the requirements of the war.

The Properties of Powders

AT THE meeting of the Faraday Society held jointly with the London Section of the Society of Chemical Industry on March 1, Dr. T. Martin Lowry, O.B.E., F.R.S., and F. C. Hemmings presented a paper on "The Properties of Powders," which embodied an investigation that had been carried out for the Scientific and Industrial Research Department under the auspices of a committee appointed by the Council of the Faraday Society.

The caking of salts is in general dependent on the presence of a solvent, usually water. The following cases have been studied:

Nitrates

In the case of ammonium nitrate, very hard caking follows the change of state which takes place at 32 deg. C., but this caking can be prevented by very thorough drying. Hard caking also follows upon mechanical disintegration of the warm salt, but this is also attributed to the influence of moisture released during disintegration. Ammonium nitrate crystallized from alcohol shows much less tendency to cake than when crystallized from water. Caking of ammonium nitrate due to mechanical working is only slight when the conditions are such that moisture can escape from the powder.

Sodium nitrate forms a very hard cake when stored in bulk, but this can be prevented by commercial drying, whereas it is precisely this process which gives rise to the most serious caking in ammonium nitrate. This difference is attributed to the polymorphism of ammonium nitrate, which has no analogy in the case of sodium nitrate.

Potassium nitrate, which is less soluble than either of the two preceding salts, may cake during storage, but apparently to a much smaller extent.

Other Anhydrous Compounds

Serious caking is reported to occur, not only in common salt and in soda ash, but also in potassium chlorate, potassium perchlorate, citric acid and tartaric acid. In the last four cases, caking frequently accompanies or follows the grinding of the dried crystals. This is probably due to the liberation of more moisture during grinding, and can be prevented by drying the compound during or after grinding, and packing in a dry condition.

Hydrated Salts

Caking of hydrated salts frequently gives rise to trouble, e.g., in the case of rochelle salt, borax, sodium phosphate and alum. These hydrates cannot be dealt with in the same way as anhydrous salts, since it is difficult to secure complete drying of the hydrate without partial decomposition. The view is advanced that mechanical working of a hydrated salt not merely releases included moisture, but may result in the breaking up of the hydrate similar to that which takes place when the salt is heated, just as the phenomena which accompany the formation of amorphous materials during cold-working may be compared with the effects produced by fusion. Grinding is found to be accompanied by a slight loss in weight which is recovered quickly from the air. It is not thought that this is sufficient to account for caking of the salt, which is attributed rather to recrystallization following on the disturbance of the normal distribution of water which results from the grinding of the salt, just as sodium sulphate may recrystallize in the normal form after being melted in its water of crystallization.

Loss of Sulphur Dioxide During Caking

Sodium bisulphite and sodium hydrosulphite cake on exposure to air, but this is a more complex change, since not only is water absorbed but sulphur dioxide is also liberated.

Contraction During Caking of Copper Sulphate

When powdered anhydrous copper sulphate is exposed to moist air it swells considerably during hydration, but the absorption of the final 1 per cent of water is accompanied both by caking and by strong contraction. The slight excess of water taken up by the blocks is quickly lost in a dry atmosphere when hydration and caking are complete. Caking and contraction in this case are believed to be due to the simultaneous presence of particles of the trihydrate and of water saturated with the pentahydrate, in which the trihydrate dissolves and crystallizes out again in the ordinary form. The caking of hydrated salts can be prevented by the presence of a small amount of a lower hydrate, which absorbs the traces of moisture which are so effective in producing caking in a salt which is almost fully hydrated.

Attention is directed to the disintegration which accompanies the change of state of ammonium nitrate when dried by heat and which is also observed in the dehydration of many hydrated salts. This disintegration may be used as a substitute for grinding, just as in the converse process of slaking lime by the addition of water.

Dissolution of Belgian Steel Cartel

Much interest has been aroused in industrial circles by the virtual dissolution of the steel producers' cartel (Comptoir des Aciéries Belges), which in prewar days was such an important factor in the Belgian steel industry and included such large works as the Cockerill, Providence. Ougrée, Athus-Grivegnée, Boël, Clabecq, Châtelineau, Espérance-Longdoz, and Thy-le-Château companies. The functions of the association were very important, including the fixing of prices for finished as well as semi-finished products, allocating orders among the various members and serving as intermediary between producers and purchasers at home and abroad. There is some talk of reorganizing the comptoir on former lines, but at least one important concern has announced its unwillingness to enter into a new combination.

The association, it appears, will continue to exist, but its functions are now confined to the receiving of orders, without authority to accept them for individual firms or to fix prices.

It is predicted that the organization will not last long in its present form, as its functions will tend to become purely formal. It is probably that the disorganized state of the Belgian metallurgical industry since the war has had much to do with the dissolution of this powerful syndicate. The dissolution of the cartel has not the same significance that it would have in a period of stabilized prices and normal production and demand.

The Fixed Nitrogen Research Laboratory

A Brief Statement With Illustrations of the Government Investigations Being Made on the Cyanamide, Haber and Arc Processes for Producing Fixed Nitrogen— National Aspects of the Problem

By ARTHUR B. LAMB*

THE disposition of the experimental Haber plant at Sheffield and the huge cyanamide plant and water-power development at Muscle Shoals, Ala., has been a serious problem confronting the War Department since the conclusion of hostilities.

On the one hand, these plants must be maintained in a state of instant readiness and efficiency in order to afford the military security which was the chief motive for their erection. Again, they represent a great monetary investment which the Government cannot afford to abandon or neglect. Finally, their operation would furnish a supply of cheap nitrogen which would help, at least in some measure, to meet the ever-increasing fertilizer requirements of our country.

On the other hand, the present products of these plants—namely, lime-nitrogen, ammonia and ammonium nitrate—are not immediately salable in large amounts for fertilizer purposes, either because of their intrinsic disabilities or because of the unfamiliarity of our farmers with their use.

Research Laboratory Established

To study these latter problems and because the knowledge of the fixation of atmospheric nitrogen is of vital importance to the military and economic welfare of the nation, and for other reasons, Arthur Graham Glasgow, fixed nitrogen administrator, in the spring of 1919 established the Fixed Nitrogen Research Laboratory, under the supervision of the Nitrate Division of Ordnance, with Dr. Arthur B. Lamb as director and Dr. Richard C. Tolman and Dr. William C. Bray as associate directors. The present staff (April 15, 1920) consists of a total of 108 persons, 77 on the technical staff and 31 on the business staff.

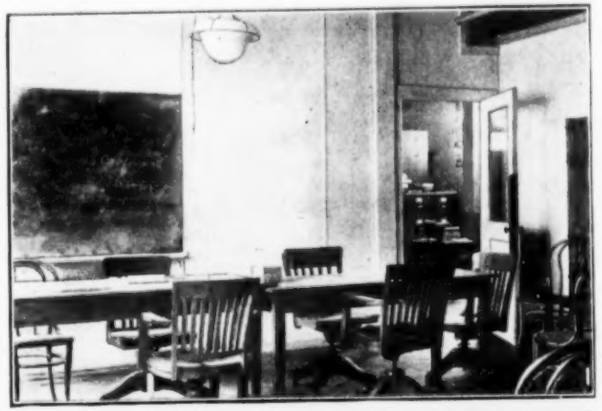
The laboratory is located at the American University, Washington, D. C., where it occupies a number of buildings, the largest of which is the Ohio Building, with a floor space of 50,000 sq.ft. These buildings, together with a large amount of scientific and technical equipment, were transferred to the laboratory from the Research Division, Chemical Warfare Service. Except for the limited technical and industrial facilities of the city of Washington, the laboratory is excellently located. The floor space is ample and the apparatus and equipment are unusually complete. Moreover, the location of the laboratory in Washington makes it possible to carry out important work in co-operation with the Department of Agriculture. Five men from the Bureau of Soils, including several who have had long experience in nitrogen investigation, are giving practically all their time to the work of the laboratory. Many tests on growing plants, both in pots and on $\frac{1}{20}$-acre and $\frac{1}{40}$-acre plots, are also being carried out in co-operation with the Bureau of Plant Industry.

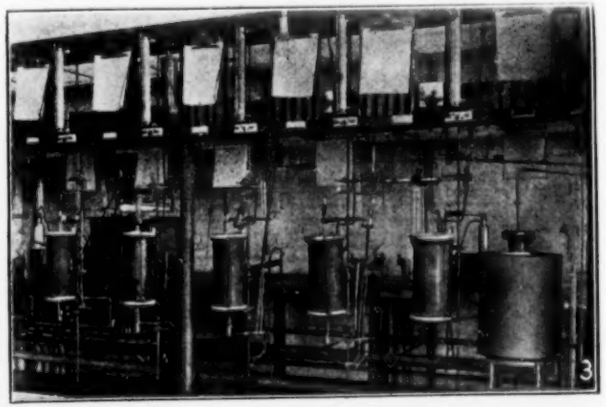
The smaller, partially completed Haber plant, U. S. N. P. No. 1, at Sheffield, Ala., never operated on a commercial basis; the large cyanamide plant, U. S. N. P. No. 2, was practically complete when the armistice was signed, and although now closed down, has been in full operation and has produced thousands of tons of product. Every part of it is well designed and functions successfully, and the whole is undoubtedly not only the best but the largest cyanamide plant in the world, with a capacity of either 220,000 tons of cyanamide or 110,000 tons of ammonium nitrate yearly.

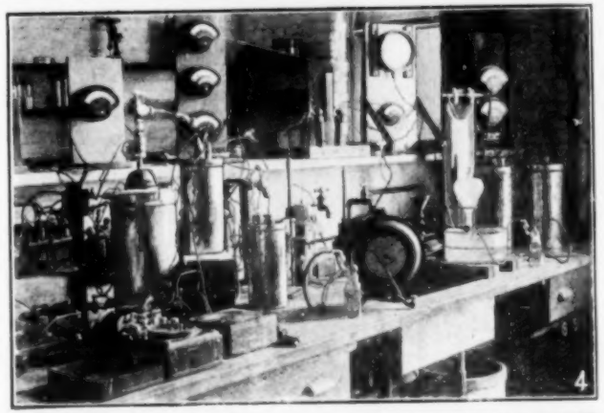
Utilization of Cyanamide

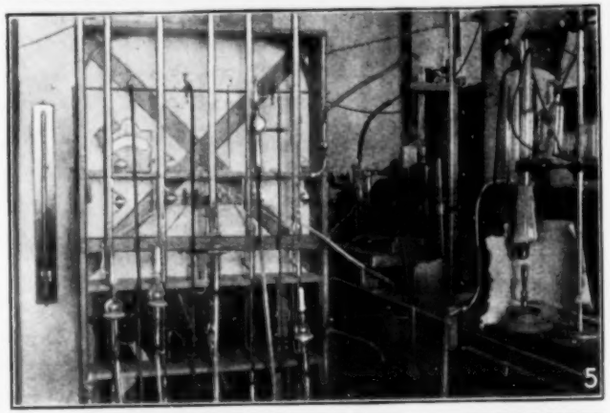
The first problem of the Fixed Nitrogen Research Laboratory has been to investigate methods for the agricultural utilization of the products of this plant. This is a problem with many angles, since cyanamide, the primary product, is a form of fixed nitrogen which at present has in America only a limited use in agriculture, and the many possible ways of increasing its use, as well as the many other forms of fixed nitrogen which can be made from it, must all be investigated. Researches along these lines have included such prob-

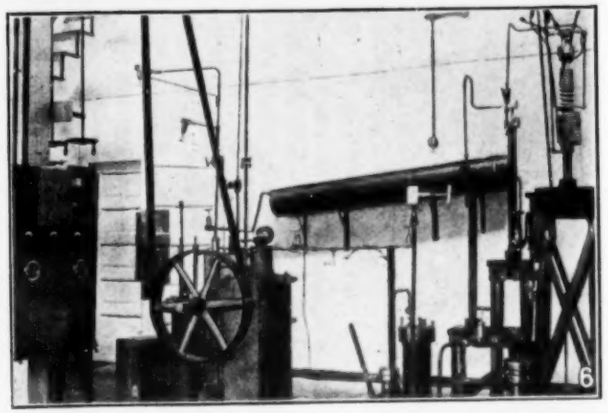
*Director, Fixed Nitrogen Research Laboratory.

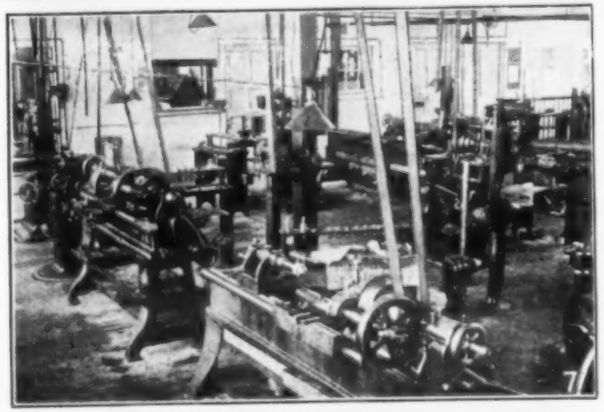


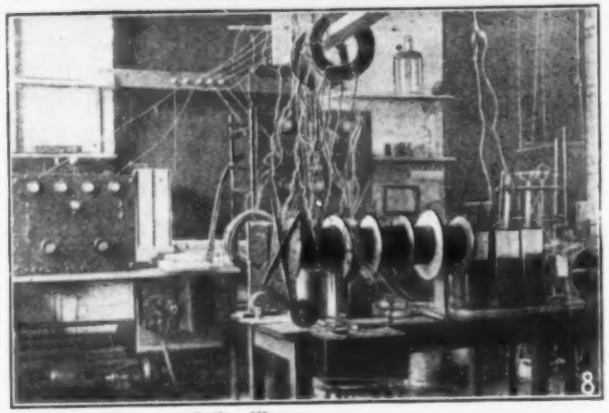












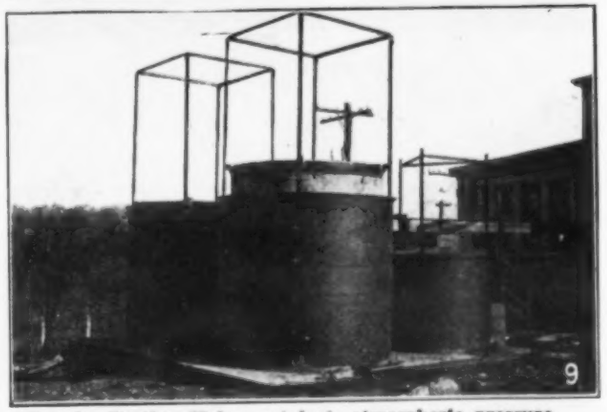


FIG. 1. Corner of conference room.
FIG. 4. Testing Haber catalyst, intermediate pressures.
FIG. 7. Corner of machine shop.

FIG. 2. Corner of the library.
FIG. 5. Adsorption measurements of catalysts.
FIG. 8. Corona discharge experiments.

FIG. 3. Testing Haber catalyst, atmospheric pressure.
FIG. 6. Ammonia absorption experiments.
FIG. 9. Gasometers for nitrogen and hydrogen.

lems as the oiling and hydrating of lime-nitrogen to reduce its undesirable properties, the granulation of cyanamide, the mixing of cyanamide with basic phosphates, the production from lime-nitrogen of a non-basic fertilizer containing urea, and the production from lime-nitrogen of ammonium sulphate, ammoniated superphosphate, ammonium phosphate, pure urea, ammonium nitrate and various double salts of ammonium nitrate. It is believed that such researches will make possible a decision as to the best methods by which this great plant at Muscle Shoals can best serve the peace-time needs of this country.

Development of N-H Catalyst

The other Government plant, U. S. N. P. No. 1, using the Haber process, has never operated satisfactorily. It represents, however, a much smaller investment than the cyanamide plant and can undoubtedly be made to operate with further study and research. The problem of the first importance in connection with it is the discovery of a robust and active catalyst for the reaction between nitrogen and hydrogen. The remodeling of the whole plant will be dependent on the ultimate choice of this catalyst. A further important problem in this redesign is the question of the best method of removing ammonia from the circulating system, and this is being investigated at the Fixed Nitrogen Research Laboratory by a group of investigators from the Bureau of Soils, working in co-operation with the staff of the laboratory. A third problem of considerable importance for the redesign of this plant is the study of those alloys of steel which are best adapted to withstand the high pressures, high temperatures and action of ammonia encountered in this process. Work along these lines is under way.

Arc Fixation Studied

Besides the above problems which are determined by the desirability of putting the two Government plants into operation, problems of less pressing importance are being studied, such as improvements in the methods of operating cyanamide plants, and the theory of the fixation of nitrogen by the electric arc. This latter process, although of considerable commercial importance where the very cheapest electrical power is available, is at present of importance in America only from a military point of view, because of the possibility

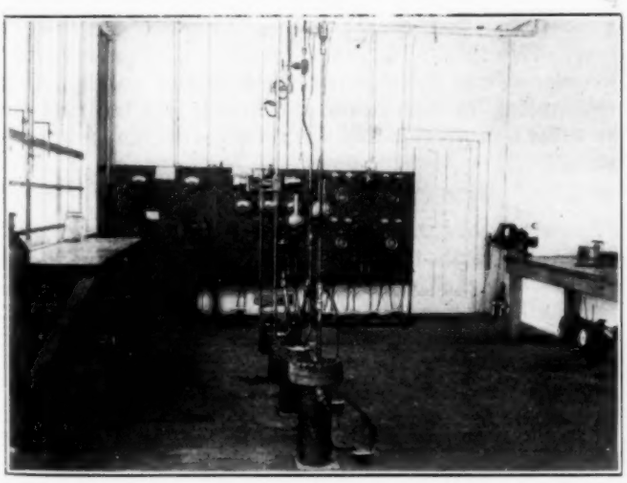


FIG. 10. TWO HABER CATALYST BOMBS AS FIRST INSTALLED

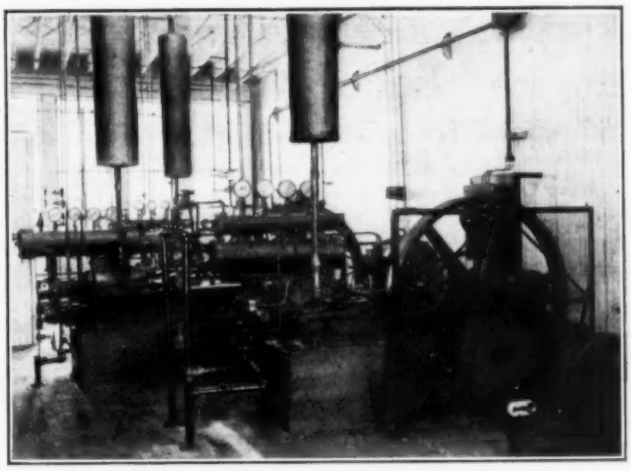


FIG. 11. COMPRESSORS FOR AMMONIA SYNTHESIS

of its rapid installation in time of emergency. A fundamental investigation of the relation between gaseous ionization and chemical reaction, however, may make this process also commercially important in America, and some work is now under way at this laboratory.

Research Situation in Germany

The activity of Germany on nitrogen research is certainly instructive. After years of extensive research and experimentation with governmental support a Haber plant with the very considerable output of over twenty tons of ammonia per day was erected at Oppau in 1913. At the outbreak of the war this was very greatly enlarged. Of all the buildings constructed at that time and in spite of their several years' successful experience with this process, the largest and finest was the Research Laboratory. It is 300 ft. long, 100 ft. wide and five stories high, and is entirely devoted to research. In August, 1919, although the plant was not operating, there were said to be seventy-five chemists at work in this building on research problems; during the war there were said to have been 250 chemists thus engaged.

The future of the Fixed Nitrogen Research Laboratory will presumably depend on legislation now pending in Congress. Senate Bill 3,390 and the corresponding bill before the House, besides providing for a self-sustaining Federal agency to operate the Government fixation plants, also specifically provides for research laboratories and experimental plants for the development of fixed-nitrogen production.

This important field of research certainly needs the resources, the scope and the disinterested point of view which the Government alone can provide.

Washington, D. C.

Industrial Experimental Laboratory in Mexico

On March 1 the Mexican Ministry of Industry, Commerce and Labor formally inaugurated an industrial experimental laboratory in connection with the commercial museum. The new laboratory is complete in every detail and is intended to offer opportunity for instruction in modern processes of manufacture to persons with small capital who are desirous of turning Mexican raw materials into manufactured products. There are in connection with the laboratory fully equipped machine shops, carpenter shops, and tin shops, with a corps of instructors for each different department.

Legal Notes

By Wellington Gustin

Contract Under War Provision Upheld

A contract, cancellation of which was due to the war, has been the subject of judicial interpretation and construction by the Supreme Court of Alabama. Whether the contract was subject to cancellation under the terms of the contract relating to war or whether such cancellation was a breach of contract was in issue between the parties, the Capital Fertilizer Co. vs. the Ashcroft-Wilkinson Co. (79 So., 484.)

The facts on which the action was founded are succinctly stated as follows: The plaintiff claimed $30,000 damages for breach of a contract entered into on May 25, 1914, by the terms of which the defendant sold to plaintiff 1,485 tons of potash, manure salts and kainit, for deliveries in November, 1914. In the second count of his complaint plaintiff claimed $3,500 for breach of a contract, entered into on July 11, 1914, for the sale of 200 tons of manure salts. Both contracts contain a clause providing: "It is understood that in case of war, rebellion or any interference by either the American or foreign government, strikes, accidents, epidemics or other contingencies happening to one or more of the mines or works furnishing or shipping the goods . . . then the seller has permission to cancel this contract."

War Set Up as Defense

In his defense the defendant set out that since the execution of the contracts one of the contingencies named as a ground for cancellation of the contract has happened, namely, that on Aug. 1, 1914, war broke out in Europe between the German Government and those of England, Russia and France, and, subsequently, on the seventh day of October, 1914, the defendant cancelled the contracts in writing.

The products of potash, manure salts and kainit were to be imported from foreign mines, by inference from the country of Germany. The contract provided for a differential duty or charge imposed by the United States or German Government, and that the foreign analyses furnished by the mines should be binding.

Contentions of the Parties

On the appeal from a judgment against it in the lower court the plaintiff contended that under the terms of the contract here in question the defendant could cancel the same only in the event of war which proximately prevented it from performing its contract; and that to construe the contract as giving the absolute right of cancellation in the event of war anywhere, without regard to its effect upon the ability of the seller to comply with its terms, would be both unusual and unreasonable. In opposition the defendant contended that the parties have, by the language used, created an absolute option to cancel the contract upon the happening of certain specified contingencies, one of them being "in case of war," and that the parties "meant what they said and said what they meant" when they placed this absolute option in the coptract; that it means war—any war, anywhere; that in using the language plain and unambiguous, the parties have exercised the constitutional freedom of the contract, and they had the right to specify the event of any war anywhere as a signal for a right to cancel on the part of the seller."

The defendant strenuously insisted that the plain and unambiguous language of the absolute option given the seller in the contract was not open to construction—it was, however, urged that, if open to construction at all, it would only be to the extent of ascertaining what war was in contemplation of the parties when the contract was made. The furthest point in such a construction would be that the parties contemplated, by the language used, a war either in this country or Germany, from which country the products were to be obtained.

Court Construes Contract

The cancellation clause refers to rebellion, or any interference by either the American or a foreign government. Besides other alternatives the one here concerned is: "It is understood that in case of war . . . then the seller has permission to cancel this contract." Said the court: "We are of the opinion that this part of the cancellation clause here in question is properly construed as having reference to a war either in this country or in Germany, from which latter country it sufficiently appears the products were to be obtained."

This point being determined, the next point for consideration was that urged by the plaintiff that the war, within the meaning of the words in the cancellation clause, must be such that it becomes the proximate cause in preventing the seller from performing the terms of the contract.

Now there is a class of cases in which the language used in the contracts indicates that the contracts were made either subject to or contingent upon strikes, accidents or contingencies beyond the seller's control, and necessarily required construction to ascertain the meaning. But in the language quoted above the seller is given the absolute option to cancel the contract in case of war.

The court said that the effect of the war in Germany or in this country upon the ability of the seller to comply with the contract here was an unknown quantity, as well as its effect upon the transportation of goods, the risk incurred, the price of goods, and the freight rates; all of these in case of war are left in a state of uncertainty. It is not merely the question of ability to obtain the goods, but also the question of the great risk, in the happening of such events, both as to prices and freight rates. "We think, upon consideration, that the cancellation clause was not without some reason and business sagacity for its foundation, and that it was inserted for the seller's protection and with a sense of business prudence."

Contract Obligations Defined

In a cited case the court said: "The contracts of men are laws prescribed by themselves to govern their transactions with each other, which, as long as they interfere not with morality or with the interests of third persons, are conclusive obligations on the immediate parties to them."

It was a part of business sagacity that seller had the cancellation clause as to war, in the broad and sweeping terms "in case of war," so written in the contract. The right to cancel arose as soon as war occurred in Germany, whether such war was the proximate cause of any inability to perform on seller's part or not.

Diatomaceous or Infusorial Earth*

By W. C. Phalen†

DIATOMACEOUS earth is more commonly known as infusorial earth, and is sometimes referred to by its German name "kieselguhr." It is also, though erroneously, called tripoli. It is composed of the siliceous remains of minute aquatic plants known as diatoms, which are of minute proportions as a general rule, and have to be identified chiefly by aid of the microscope. The organic matter of these plants has long since disappeared from most of the deposits, but there are notable exceptions, as in California.

These low forms of plant life secrete silica much after the same manner as mollusks secrete lime and thus build up their shells. It is this part of the plant which makes up the formations found in nature. The siliceous parts accumulate on the bottoms of the bodies of water in which the plants lived, and in time attain considerable thickness, and become of economic importance. The diatoms may live in either fresh or salt water, and under varying conditions of depth, pressure and temperature. For example, they have been found in the depths of the Atlantic Ocean, and are known to occur in the warm springs of Yellowstone National Park, to cite two extremes of temperature, pressure and difference in the character of the water. The material is now in process of formation and although it has in times past been formed in very different epochs, it is especially abundant in the Tertiary, and most of the known beds of great thickness are of this age.

Chemical Composition

In chemical composition, diatomaceous earth is a hydrous silica or opal, but as a rule it contains a considerable quantity of earthy impurities. A very simple test, taken in connection with other distinguishing characteristics, is that when touched with hydrochloric acid it does not effervesce. Sometimes analyses from widely separated localities show great similarity of composition; as, for example, the first three analyses in the accompanying table.

ANALYSES OF DIATOMACEOUS EARTH

	1	2	3	4	5	6	7	8
SiO_2	80.53	80.66	81.53	75.68	65.62	86.92	72.50	86.89
Al_2O_3	5.89	3.84	3.43	9.88	.....	4.27	11.71	2.32
Fe_2O_3	1.03	.....	3.34	2.92	.....	.....	2.35	1.28
CaO	0.35	0.58	2.61	0.29	.....	1.60	0.32	0.43
MgO	.....	.....	.....	0.69	.....	Trace	0.83	Trace
K_2O	.....	.....	1.16	0.02	.....	2.48	1.88	3.58
Na_2O	.....	.....	1.43	0.08	.....	.....	.....	.....
H_2O	12.03*	14.01*	6.04*	9.21†	11.00	5.13	9.54	4.89
	99.83	99.09	99.54	98.77	.....	100.40	99.13	99.3

* Water and organic matter.
† Nitrogenous matter and moisture.
1. Lake Umbagog, New Hampshire.
2. Morris Co., New Jersey.
3. Pope's Creek, Md.
(Note: The above three analyses are quoted from Merrill, G. P., Non-Metallic Minerals, 2d Edition, 1910, p. 72.)
4. Darton, N. H., U. S. Geol. Sur. *Bull.* 483, p. 27, 1911.
5. Soft Diatomaceous Shale, Harris, Santa Barbara Co., California, W. T. Schaller, analyst.
6. Porcelain diatomaceous earth, Pt. Sal, Santa Barbara Co., California, Faifbanks, H. W., *Bull.* Dept. Geol. Sur., Univ. Calif. vol. 2, 1896, p. 12, sp. gr. 2.12.
7. Soft diatomaceous shale, Orcutt, Santa Barbara Co., California, W. T. Schaller, analyst, 1908.
8. Monterey, Monterey Co., California, A. C. Lawson and J. de la C. Posada, Dept. Geol., Univ. Calif., vol. 1, p. 25, sp. gr. 1.8 to 2.1.

Uses

The chief use of diatomaceous earth is as a cleanser and polisher, and for these purposes it is used in the form of a powder or mixed with soap. It is a most effective non-conductor of heat, and has been used alone or with various compounds in covering for boilers, steam pipe, furnaces and stoves, and in the manufacture of fireproof cements.

It has great absorbent qualities, as will be noted from the fact that its specific gravity, bulk for bulk, is only one-third that of water—namely, 0.33. Its absorbent quality makes it suitable for water filters. The statement has often been made in the literature that it has been used in the manufacture of dynamite, but I understand that its use for this purpose has long since been entirely supplanted by wood pulp, on account of the danger from particles of grit. Boiled with shellac, it is used in the manufacture of records for talking machines.

Its uses abroad have been more numerous than in the United States. It had been used in Europe for the absorption of liquid manures so as to make the latter conveniently available as a fertilizer. It has also been used in the manufacture of water-glass, in making cement, in tile glazing, artificial stone, ultramarine and other pigments of aniline and alizarine colors, paper filling, sealing wax, fireworks, hard rubber objects, matches, papier maché, as a container for liquid bromine and for miscellaneous minor purposes.

In California it has been used in the construction of buildings, advantage being taken of its property of being readily cut into any desired shape or size. In some of the California reports, it is referred to as shale. It is easily quarried, and the small blocks into which it may be cut are light in weight and placed easily in position. In powdered form the material has been used to a certain extent in California in the manufacture of plaster.

Preparation of Material

In preparing the earth for industrial use it is first roasted to expel as much water and organic matter as possible. It is then transferred to a furnace and heated to a moderately high temperature, but with the exercise of sufficient care so as not to destroy its porosity by overheating. It is then finely ground between rollers, sifted and sacked to prevent re-absorption of moisture. For certain purposes, it is only necessary to give it a prolonged drying at a high temperature prior to grinding and sifting.

In Santa Barbara County, California, the material is broken in open air quarries and as mined contains a considerable percentage of moisture. After forty to fifty days of drying in the dry atmosphere of southern California, the material still contains a small percentage, approximately 5 per cent, of moisture. Some of the material after air-drying is sawed into bricks or other shapes and dried in kilns. Such bricks are used for insulating purposes. The rest of the material is finely powdered in mills and sacked to be used for filtering. Quarrying is done by electrically driven channeling machines. Some of the California material contains 5 per cent of alumina, presumably in the form of clay, which acts as a binder. This material is adapted to the use of building blocks for interior fireproof walls, and contains about 85 per cent silica.

One of the deposits near Lompoc—namely, that of the Celite Products Co., formerly the Kieselguhr Company of America—comprises extensive beds of soft white earth in a very pure state, both thin and massive. These form a cap over the hills and overlie brown

*From Bureau of Mines Monthly Report on Investigations, March, 1920.
†Mineral technologist, Bureau of Mines.

siliceous shales and are conformable with them. The strike is east and west and the dip is 30 deg. south. This material is being quarried in open cuts. It is taken up in large blocks and air-dried in the quarry. It takes from forty to fifty days to reduce the water content, which ranges from 25 to 45 per cent by weight, to 5 per cent. It is then hauled by motor trucks to the plant at Lompoc, where it is ground to powder and transferred to the different warehouses by a pneumatic system. When blocks are required, the material is transported in its natural state direct from the quarry, sawed to the required sizes, and dried before shipment. The material, when dried, is utilized in making brick, tile and other refractory materials.

The quarry operations are readily carried out where transverse joints occur in the strata due to earth movements. Where these are not present to facilitate removal of the rock, it is necessary to loosen it slightly by means of powder before blocks can be removed from the quarry face.

On account of the quantity of absorbed surface water in the diatomaceous earth, it is necessary that it be split into convenient blocks for drying.

Deposits in the United States

That infusorial earth is a widely distributed commodity in the United States is evident from the descriptions given below. The localities outlined are doubtless far from being a complete list. They are given principally to indicate the widespread occurrences of the material.

Maine: A deposit of diatomaceous (infusorial) earth of unknown extent is reported to have been worked in South Beddington, Washington County. The material is said to be of pure white color and of unknown extent.

New Hampshire: Beds of diatomaceous earth are reported from the vicinity of Lake Umbagog. An analysis of this material is given above.

Massachusetts: Beds of infusorial earth are said to occur near South Framingham.

New York: Two deposits of infusorial earth are known in the State of New York—namely, at White Lake, Herkimer County, and at Cold Spring Harbor, on Long Island. It is likely that careful prospecting will reveal other deposits in some of the larger peat bogs and marshes of the State.[1]

New Jersey: Near Drakesville there occurs a deposit which covers a small acreage to a depth of 1 to 3 ft.

Maryland: Infusorial earth has been mined along Lyons Creek, a branch of the Patapsco River, separating Calvert and Anne Arundel Counties. The location is five miles west of Herring Bay, on the west shore of Chesapeake Bay. Deposits are also known extending from Fairhaven, on Herring Bay, to Pope Creek, on the Potomac River. It occurs at the base of the Calvert formation, which is Miocene (Tertiary).

Virginia: Diatomaceous earth occurs also in the Calvert formation of the Chesapeake group in the vicinity of Richmond, Va. The lower beds of the formation, chiefly those between 5 to 20 ft. from the base, contain diatom remains in sufficient quantity to entitle it to be termed diatomaceous earth. In weathering, the portions rich in diatom remains become nearly pure white. The material is of very fine texture, and is very light gray to white in color. Its lightness is characteristic, having a specific gravity of only 0.33, bulk for bulk. It outcrops especially in the valley of Shockoe Creek. The available material here is not so great in extent as at some other localities in Virginia and Maryland. The purer deposits are soft and clay-like, and when dug are very porous with a white or slightly yellowish tinge.

Florida: The Florida deposits of diatomaceous earth have been formed in fresh water, and are of comparatively recent date. A deposit located at Eustis, which has been worked to some extent, is in general appearance very much like the peat bogs of that section. The diatomaceous earth is in fact intimately mixed with peat or muck, and the material as taken from the bogs looks like peat of a grayish color. The method of treatment is to burn out the carbonaceous matter, leaving the siliceous material as a very fine white powder. The deposit in this bog has a thickness of 20 ft. or more.

About three miles east of Tavares, on the north side of Lake Dora, is a bog of the peat prairie type covering 100 acres. In 1901 a plant to treat the infusorial earth was erected on the north edge of this prairie a few hundred feet from the Sanford and Eustis division of what is now the Atlantic and Coast Line R.R. Besides the occurrence near Eustis, Lake County, a number of samples of similar material have come from Polk County.

It is reported that the Eustis product was at first shipped to England for use in making scouring soap.

New Mexico: Near Socorro there is stated to be a deposit of fine quality which outcrops in one place 1,500 ft. long and with a thickness of 6 ft.

Nevada: A deposit of diatomaceous earth is reported in a railroad cut west of Reno, Nev., with a thickness not less than 300 ft. and varying from a pure white to a pale buff or canary color.

Oregon: Near Linkville, Klamath County, there occurs a deposit of infusorial earth which has been traced a distance of ten miles, and along Lost River it shows a thickness of 40 ft.

Idaho: Beds of diatomaceous earth are known to occur in Idaho.

Washington: Beds of diatomaceous earth are known to occur near Seattle, Wash.

California: There are a number of deposits of infusorial earth in California. The most important thus far developed are in Santa Barbara, Monterey, Orange and San Luis Obispo Counties. The material in Santa Barbara County is of superior quality and has been worked on a commercial scale. Infusorial earth is also found in Fresno, Kern, Los Angeles, Plumas, San Benito, San Bernardino, San Joaquin, Shasta, Sonoma and Tehama Counties. During 1918 five quarries operating in Monterey and Santa Barbara Counties produced a total of 36,000 tons of this material, valued at $190,000. The most important deposit is that of the Celite Products Co., formerly the Kieselguhr Company of America, the name having been changed during the war. The quarry and mill of this company are at Lompoc, Santa Barbara County. This company has rapidly increased the scope of its dust operations, and it is reported that it expects to still further increase them. There is still another operation in the same vicinity by the name of La Salle Canyon quarry. Near Bradley, in Monterey County, there have been two small operations, and possibly a third. The deposits of northern Santa Barbara County have been described in great detail by Ralph Arnold and Robert Anderson in Part I of U. S. Geol. Sur. Bull. 315 (1906).

[1]Parsons, A. L.: "Peat, Its Formation, Uses, and Occurrence in New York," 57th Ann. Rept., N. Y. State Museum, vol. 1, sec. 1 (or 23d Ann. Rept. State Geologist, Part 1); 15-80-1905.

Reliability of Materials and Mechanism of Fractures*

The Focus of Impact Fracture Is Below the Surface Opposite the One Receiving the Blow, and the Metal or Amorphous Substance Splits Along Radiating Surfaces, Overlapping or Separated by Ripples Which Further Out Develop Into Major Fracture Planes

BY CHARLES DE FREMINVILLE†

RELIABILITY is the quality we desire in the metals we use, but it is very difficult to ascertain it through a short test. The reliability of materials is like the reliability of friends. Whatever brilliant qualities they may exhibit, their reliability is known only in the long run, so that in the case of an apparent failure, the qualities of a metal, like those of a friend, should not be questioned too quickly. It is not enough to know the intrinsic qualities of the metal; a very careful study of the circumstances under which the failure occurred must also be made, and it is this fact which has made the study of fractures and of the mechanism of fractures one of great interest to the author.

During the early days of the automobile industry the problem of resistance of materials began to be considered in a new light. The first motor cars that were built were designed with factors of safety then generally accepted for the resistance of medium-carbon steel. But the engineer soon came into contact with the sportsman and was tempted to put into the gearing a stress much greater than the one for which it had been made. One of the problems to be solved, therefore, was to secure a material which could safely be used for gears.

At that time steel makers had produced, among certain other new products, ternary steels, which showed brilliant promises of new qualities if the results of the laboratory tests to which they had been submitted could be taken as a proof of their reliability.

Viewing the question of material for motor cars in a general manner, the constituent parts appeared to belong to two distinct classes. The first included such parts as gears, crankshafts, connecting rods, etc., which had to withstand severe normal shocks. Also only a small amount of wear was allowable and the class of accidents to which they were liable was limited, being chiefly those of seizing or an encounter with stray nuts or bolts.

The parts of the second class did not have much stress imposed upon them in ordinary service, but they did have to meet with what can be termed "normal accidents," and were therefore expected to bend to a certain extent without ceasing to fulfill their duty. To this class belonged front axles and, more generally, all the parts connected with the steering mechanism. For these, the "normal accident" can happen very frequently. It is almost impossible to say that the wheel of a car will not come rather abruptly into contact with a curbstone, or even with the wheel of another car. In such case something must yield or break. It is of course but natural to hope that something will yield and that this yielding has been foreseen; also that it will take place on a piece easily seen and easily replaced, and that the material of which the piece is made will not cease to be reliable.

The impact test, to which attention was directed at that time in France by M. Considère and later by M. Frémont, seemed to be a very convenient method for ascertaining the characteristics of the parts of each class. The impact test, however, was devised primarily for soft steel and had to be adapted for very hard steel. But by making use of the impact test it was possible to select for the parts of the first class a grade of steel which only fractured after a very small amount of deformation, and this could be considered as a very excellent quality for the parts of this class.

The parts of the second class were expected to bend under the impact test to a very great extent, and it was easy to find wrought iron or mild steel possessing this characteristic, although the reliability of these materials for the use considered is a matter open to discussion. But here again the problem became complicated, because there were those who seemed reluctant to admit that some of the parts had to bend easily under certain circumstances and that a limited amount of toughness was not desirable, inasmuch as the steel maker pretended to have grades of steel uniting in a rare degree ductility with toughness.

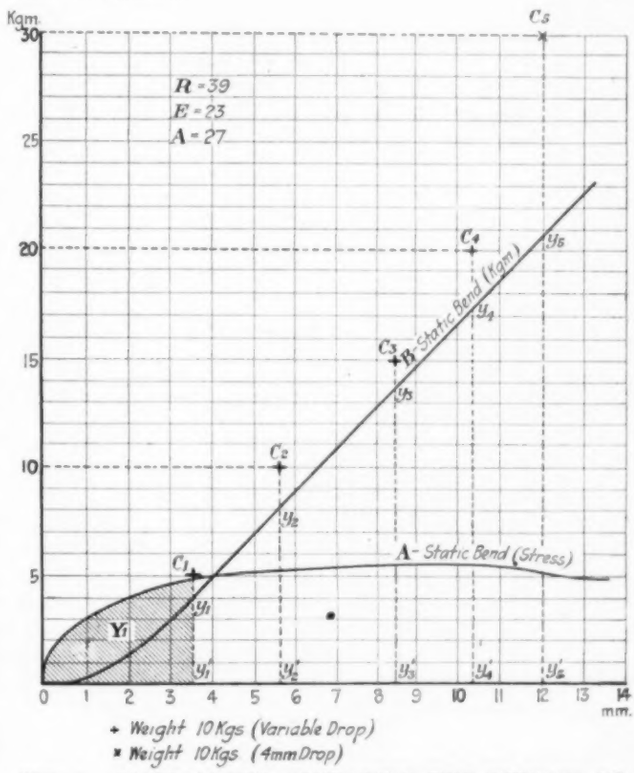


FIG. 1. DIAGRAM FOR COMPARING THE RESULTS OF STATIC BEND AND DROP BEND TESTS

*Presented at the annual meeting, New York, December, 1919, of the American Society of Mechanical Engineers, and printed in their *Journal*, April, 1920. A brief abstract of his address was given in CHEM. & MET. ENG., vol. 21, p. 613 (Nov. 12-19, 1919).

†Architectural and industrial engineer, Paris, France. Consulting engineer, Schneider Works. Hon.Mem.Am.Soc.M.E.

The tensile tests of these steels showed a high ultimate strength and a great elongation. The impact test showed that a considerable amount of energy had been absorbed by the test piece, which gave a great amount of distortion. It is evident that if it had been possible to have a diagram of the impact test, showing at every moment what was the amount of stress corresponding to a given deflection, the matter would have been made very much clearer. But since there was no machine that would give such a diagram, a substitute was found in a static bending machine registering the amount of energy taken in the deformation process. It was possible to ascertain that in all the cases which had to be investigated, the number of kilogram-meters absorbed was practically the same as in a quick bend or in a drop test. So far as the appearance of the fracture was concerned there was no perceptible difference in either case,

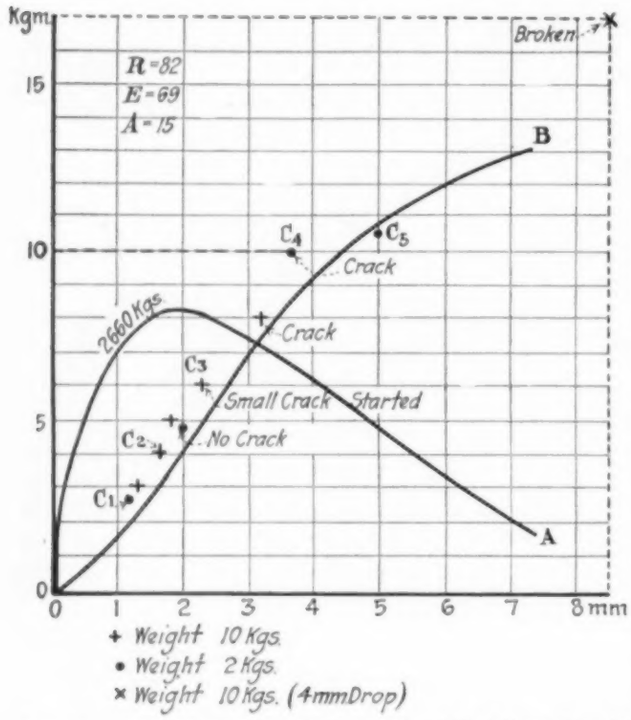


FIG. 2. DIAGRAM FOR COMPARING THE RESULTS OF STATIC BEND AND DROP BEND TESTS

which showed that the metal which seemed to possess ductility and toughness did not possess these characteristics to the extent believed.[1]

Figs. 1 and 2 are diagrams for comparing the results obtained by drop tests and quick-bend tests on notched test pieces. In these diagrams the ordinates of curves A are proportional to loads corresponding to deflections shown on the abscissa scale. In curves B (which are the integrals of curves A,—ordinates $y_1y'_1$ being proportional to surface V_1, and so on) the amount of energy consumed in the bending test is given for each value of the deflection. The ordinates y'_1C_1, y'_2C_2, etc., are proportional to the amount of energy absorbed by the drop test for the same deflection, as measured in the bend test, and can be easily compared with $y_1y'_1$, $y_2y'_2$. The energy absorbed in the drop test appears to be only slightly greater than that absorbed in the quick-bend test, but the process has followed the same course in

[1]The author has recently learned that the same idea of interpreting a drop test by means of a diagram given by a static bend test has been successfully used in this country for testing rails, and he believes that it can be used in many instances.

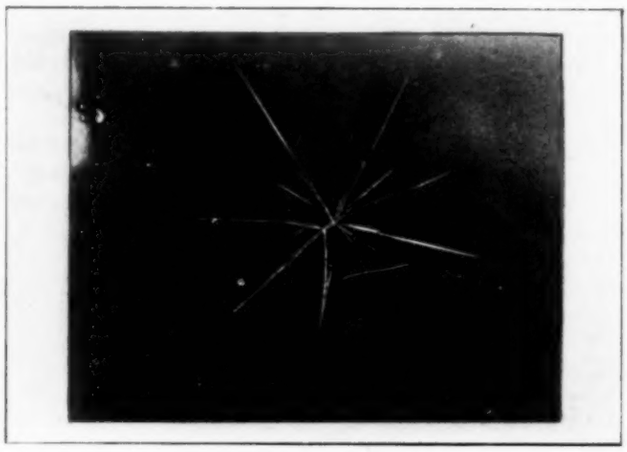


FIG. 3. RESULT OF SHARP SHOCK ON A GLASS VESSEL

both cases, and the difference may be attributed to errors in the experimental work.

Fig. 1 is a diagram of a test of wrought iron or mild steel in which the amount of stress necessary to obtain a given deflection remains constant over a long range. This is the type of material which can be expected to give good results for parts of the second class.

Fig. 2 is a diagram of a test of a steel with a certain amount of ductility, in which the energy consumed for a given deflection appears to be greater than in the case of Fig. 1, and which was offered for parts of the second class. It should be noted that in Fig. 2 curve A is absolutely different from curve A of Fig. 1, as it shows that a maximum amount of the energy is absorbed after a small deflection has been obtained. This maximum is the point where the piece begins to show a crack, which of course did not exist in the test piece whose diagram is shown in Fig. 1.

Parts of the second class made of this metal proved a decided failure. Even without experiencing the "normal accidents" which they were expected to withstand, they showed a great tendency to crack without the slightest deformation, which method of fracture has been called *fissillité* by the late M. Brustlein, of the Jacob Holtzer firm, Unieux, France.

By looking closely into the fracture of the broken test piece, which was supposed to possess ductility and toughness, it could be seen that most of the distortion,

FIG. 4. DEVELOPMENT OF THE FRACTURE RESULTING FROM A SHOCK ON A THIN SHEET OF GLASS

or flowing of the metal, had taken place not before the fracture was started, but during the process of extension of the fracture, and this gave to the amount of energy recorded an altogether different meaning. In this case the failure of the material could be traced to a bad interpretation of the test, but other failures were encountered which could not be traced to the quality of

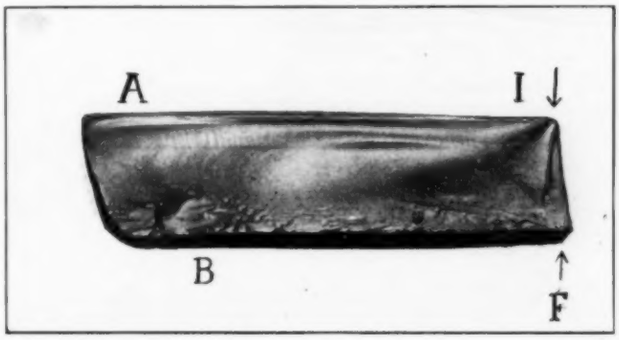


FIG. 5. FRACTURE SURFACE IN A SLAB OF GLASS

the metal used. Typical among these was the sudden snapping of levers, under conditions which could be specified but which were difficult to explain. The impact test, like others, could not give a clue as to reliability in certain circumstances.

THE STUDY OF FRACTURES

The uncertainties in the behavior of material, the propagation of a crack without any distortion of the piece, the sudden snapping of a rod without any perceptible alteration in the neighborhood, even the changes which were produced in brittleness under heat treatment, appeared to be difficult to account for, and it seemed to the author to be worth while to add to the theoretical views of the question by making, as far as possible, a thorough study of the fracture itself, which would tell, in some cases, the story of the failure.

It is frequently believed that fracture is a form of failure of such peculiar character as to escape all rules.

FIG. 6. SMALL SPLINTERING FOCUS GLASS

However, the attention of the author was first attracted by the very regular fractures of sandstone, which is used extensively in France for pavements, and which so resemble one another that they seem to be real diagrams of what has happened during the rupture. Moreover, a certain number of peculiarities of the fractures were found to be common to both sandstone and steel. It was also noticed that these same features were found in glass fractures, in which they could be observed with great accuracy; also that they were still easier to observe in Judea bitumen, where the breakage was produced very easily. A further study has shown that the fractures developed in an identical manner in these various materials.

It is not possible in the limited time at the disposal of the author to go thoroughly into the subject of the study of fractures, and as a result attention can only be called to some of the main features. Fig. 3 shows a fracture developed in a glass vessel by a sharp shock. In this should be noted the symmetry of the surfaces originated and the peculiar disposition of the starting points of these surfaces from both ends of a small line to which the surfaces are tangent. Fig. 4 shows the development of the fracture resulting from a similar

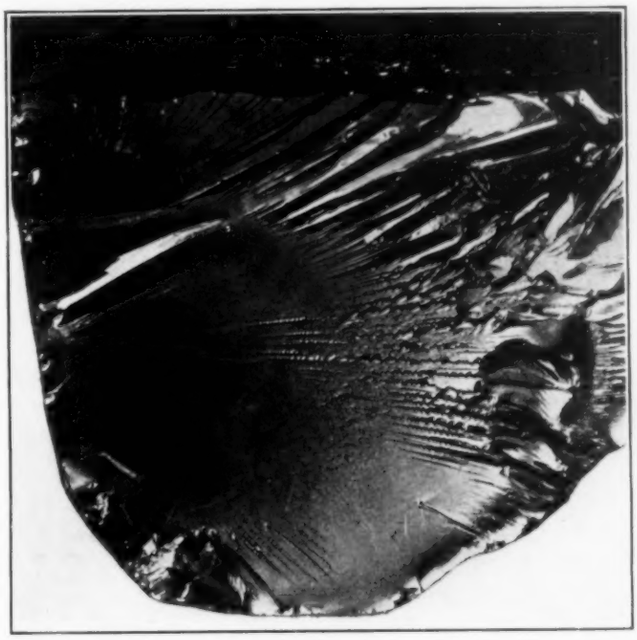


FIG. 7. FRACTURE IN JUDEA BITUMEN

shock in a thin sheet of glass. Here great symmetry is seen, the network also originates from a small line, and some of the surfaces extend entirely through the glass, some only partially.

Fig. 5 is taken from a slab of glass broken in the same manner. It shows one of the surfaces dividing the slab into pieces, which was also partially cut by other surfaces. In this particular case the blow was given at *I* on the top of the slab, and it will be seen that the small line, noted in the previous figures as the origin of all the cracks, is situated at *F* at the opposite side of the surface. It presents a very remarkable appearance and the general disposition of the surface induces us to believe that the fracture originated in that region.

Fig. 6 shows in great detail another specimen, which illustrates very clearly that there is a starting point of the fracture. Many such examples enable us to see that one of the main surfaces cutting the test sample has not expanded at one stretch, but is formed by surfaces overlapping each other like the blades of a fan. This is made still more evident by the fracture shown in Fig. 7. These surfaces overlap each other at distances often smaller than a hundredth of an inch, and by making use

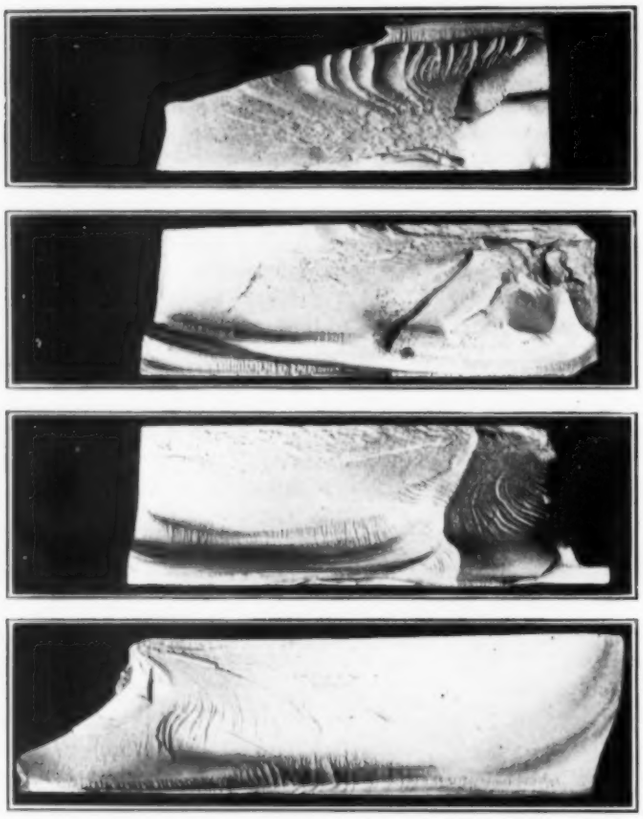


FIG. 8. FRACTURE IN TOOL STEEL

of the method called *recoupement* (recutting) by the geologists, it is possible to follow the successive order in which the various elements of the fractures have developed.

Fig. 9 shows in greater detail one of these surfaces, and enables us to point out some of its special features. Part of the surface is bright and part dull. A study of the bright part can be made from Fig. 7, which shows a standard fracture in Judea bitumen. It is very easy to

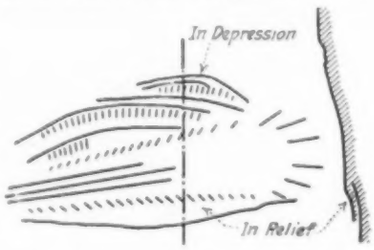


FIG. 9. SCHEME OF FRACTURE IN JUDEA BITUMEN

FIG. 10. RENTS FORMED UNDER THE MAIN SURFACE IN GLASS

follow the surfaces overlapping each other, as is shown by the scheme in Fig. 11. The general arrangement of the surfaces bears a very close resemblance to the surface of water as it runs in a culvert, passes over a dam, or expands in a shallow pond.

The same arrangements of fractures, overlapping surfaces, foci, etc., which are easily observed in glass and Judea bitumen are also met with in tool steel, as shown in Fig. 8.

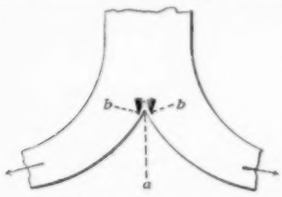


FIG. 11. SCHEME OF TEARING, WITH CRACKS THAT ACCOMPANY IT

We find that the dull part gives the impression that it has been rent or torn away, while the bright surface seems to have been carefully cut. Fig. 10 shows how the dull surface is originated by small rents coming from under the surface. If now we come back to the focus of Figs. 6, 7 and 8, and look for the point where it has been originated, we find that it also lies under the surface.

Fig. 11 shows what takes place in the tearing of a tough substance such as gelatine. The cracking (*bb*) travels ahead of the parting at *a* and prepares the way for its advance.

Fig. 12 is another and striking example of the tearing of a tough material. The parting at the edge of the

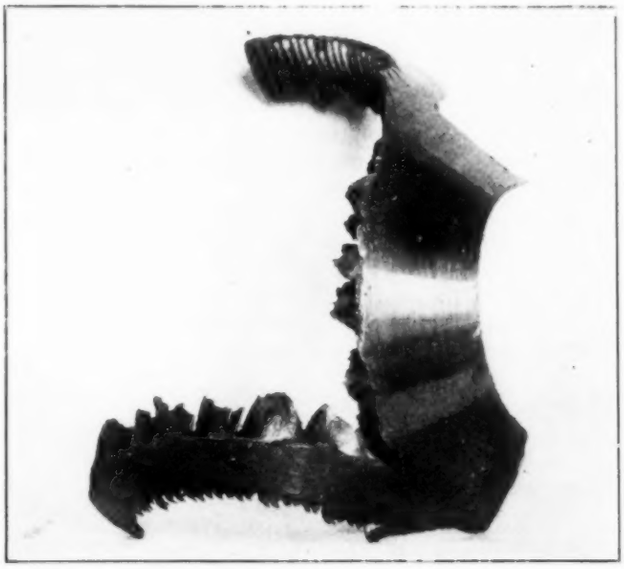


FIG. 12. STEEL CHIP

tool has been made possible by a "cracking" similar to that shown in Fig. 11. The sketch in Fig. 13 shows the scheme of the formation of the steel chip.

But how can a bright surface be produced? How can the cutting process be carried on without the subsurface cracking? How can surfaces be cut which run parallel within such small distance as the ones we have noted? The only explanation which seems to be satisfactory is that the cutting power is a vibratory motion of the surfaces of the fracture, so long as they do not join each other.

Stress and Strain

What are the conclusions to be drawn from this brief presentation of the mechanism of fractures? How can it pretend to be a contribution to the science of resistance of materials? In a general way, by showing the

succession of the phenomena which have taken place during the spreading of the fracture, it affords an experimental proof that the straining effects are more detrimental to the material than mere stress. This is in accordance with what has been shown by a purely mathematical study of the question.

In case of an impact fracture, be it in a piece of glass or in a piece of steel, we find the starting point of the fracture under the surface, although the maximum stress must certainly be located on the surface itself.

In the case of a piece subjected to tension only if a comparison is made with the fractures already considered it will show that fracture has originated along the axis of the test piece. (See Fig. 14.) The surface of the test piece itself sustains a very important stress, but without being subjected to the strains resulting from the contact of layers undergoing uneven stresses, flowing, so to speak, to give the reduction of area.

The predominance of the internal or straining action is no less striking in the case of a rent where the straining effect travels in advance of the stress which could be originated at the separating point. (See Fig. 11.) This condition should induce the metallurgist to pay more attention to the causes which produce straining; in other words, to the tensions which may exist in the pieces after being cast or forged. This is illustrated by the changes in brittleness which occur in glass undergoing heat treatment. The heat treatment does not bring about any change in its molecular arrangement, but the glass coming out of the furnace is very brittle, and after being properly annealed is so much less so that it is in the so-called unbreakable state; that is to say it can sustain shocks and bending to a much greater extent than ordinary glass.

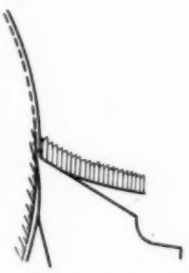


FIG. 13. SCHEME OF STEEL CHIP

The first condition is one of very uneven tension; the second, one without tension; and the third, one which has a beneficial tension. This unevenness of tension also exists in steel, irrespective of the chemical or other changes in structure. An example of the effect of these internal tensions is given by Fig. 15, which shows a fracture in a rail. It is evident that the fracture was started in the neighborhood of the neutral axis, a fact which could not be accounted for if the piece had been under normal conditions; therefore the causes of a fracture of that kind must be traced to a tension most likely produced in the rolling mill. This case illustrates the mode of cutting which produces bright surfaces in glass, and which can only be explained by the presence of a vibratory motion of the surfaces when they are apart from one another.

FIG. 14. TEST PIECE RUPTURED UNDER TENSION; FRACTURE ORIGINATED ALONG THE AXIS

FIG. 15. TENSION FRACTURE IN STEEL RAIL

In conclusion, the author trusts he has created the impression that a methodical study of fractures is of the greatest importance, especially as it leads to a knowledge of the causes of failures which cannot always be attributed to the intrinsic qualities of the metal itself.

United States Third in Visible Nitrate Supply

The Association of Producers of Nitrate has made public certain statistics concerning the consumption of this product, according to an Associated Press dispatch.

In the month of February there was on hand in Europe a stock of nitrate of 150,000 tons, and during this same month there was imported into Europe 237,000 tons. Of this total of 387,000 tons there was delivered to the consumer during February a total of 155,000 tons, which left on hand for the month of March a total of 232,000 tons.

The visible supply of nitrate reaches 2,102,000 tons, composed as follows: 1,252,000 from Chile, 492,000 in Europe, 277,000 in the United States and 81,000 in Japan and other countries.

To the 237,000 tons imported by foreign markets during February there should be added 12,500 tons transshipped in the United Kingdom. This gives a total for imports in February of 249,000 tons. The distribution of these imports was as follows: United Kingdom, 11,000; France, 90,000; Belgium, 21,500; Holland, 22,000; Spain and Portugal, 18,000; Italy, 39,000; Scandinavia, 31,000; Egypt, 7,500; Germany and Baltic ports, 9,000.

Production of Sandalwood and Sandalwood Oil in India

A report has been prepared showing the development of the sandalwood oil industry, which is practically a monopoly of the Mysore Government of India, and the distribution of this trade in previous years. The oil is used in the preparation of certain medicines, perfumes and scented soaps.

Australian Flax Industry*

THE Commonwealth Flax Industry Committee, which was established by the Australian Government on the recommendation of the Institute of Science and Industry, has recommended the government to continue the guaranty for raw flax. It is understood that the government does not intend to let this industry languish. Already the area under crop has been increased from 500 to 2,200 acres, and the Flax Committee anticipates that no less than 5,000 acres will be planted during next season.

Before the war Russia produced no less than 80 per cent of the world's output of flax fiber, and when the greater part of the Baltic provinces fell into German hands, as well as the flax-growing districts of Belgium, northern France and the Balkan Peninsula, the shortage of flax fiber among the allied nations for both military and commercial purposes became every day more and more acute. As a result of a meeting of agricultural scientists held in Melbourne in November, 1917, at the suggestion of the advisory council of science and industry a resolution was carried that the advisory council be asked to ascertain whether the British Government was prepared to purchase dewretted flax fiber from Australia in 1919; and, if so, in what quantities and at what price. Inquiries were instituted accordingly, with the result that the army council in England agreed to purchase the fiber from the 1918 flax crop at £170 ($827.30 at normal exchange) per ton c.i.f. The Commonwealth Government thereupon appointed a committee, under the war precautions regulations, for the control and development of the flax industry in Australia, at the same time guaranteeing all growers of fiber flax in 1918 £5 ($24.33) per ton for flax of specified standard.

Previous Efforts to Establish the Industry

For the past twenty years or more fiber flax has been grown on a limited scale in the Gippsland district of Victoria, and attempts have also been made at various times to introduce the cultivation into New South Wales and Tasmania, but without success. Owing to the scarcity and high value of labor and the low price at which flax fiber could be imported, the return the Australian farmer received for his flax did not prove sufficiently attractive to encourage its cultivation, and the few attempts made in recent years to establish the flax industry on a larger scale in Victoria ended so disastrously as to prejudice him still further against this crop. The bounties act, passed by the Commonwealth Government in 1907, provided for the payment of bounty of 10 per cent of the market value of all products from flax grown in Australia, but so little was this inducement availed of that when the act expired, in 1917, not more than 300 acres of flax were under cultivation.

It is more than likely that, in addition to the low returns for fiber and the comparatively high cost of labor, one reason for the retarded development of the flax industry in Australia was the difference in the climatic conditions as compared with those of the fiber-producing lands of Europe, and particularly with those of Ireland, in which country most of the farmers who have attempted flax cultivation in the commonwealth originally gained their experience of this crop. The system adopted in Australia is that of dewretting, the straw being spread over the paddocks in thin layers and the fermentation being brought about by the action of the dew and the sun. Again, in Ireland and in all the European flax-growing countries the custom is to pull the crop by hand, while in Australia it is cut with a reaper and binder. There appears to be no doubt that cutting is wasteful, besides being detrimental to the production of first-quality fiber; but the loss sustained by the Australian grower through the adoption of this method is probably more than compensated for by the greatly decreased cost of labor. Flax growers in Australia had had to learn by the practical experience of local economic and natural conditions, and the methods of cultivation and treatment that have proved successful in Europe may not be equally so in the commonwealth.

Work of the Flax Industry Committee

When the committee was appointed its first act was to requisition all the seed from the previous year's crop. In view of the limited quantity available, the committee decided, as far as growing flax on a commercial scale was concerned, to confine its efforts for 1918 to Gippsland, where it was known that flax could be grown with success, and where one or two flax mills were already in existence. The seed at the committee's disposal was grown in the Drouin district, and was of the variety know as "blue-flowering Riga," the descendant of a small consignment imported some years ago. The quantity available was sufficient to sow only about 1,400 acres, and for a time the advisability of obtaining a further supply from New Zealand was seriously considered. On examination of the samples admitted, however, some doubt arose as to the fiber-producing qualities of the imported seed, and it was decided to utilize only the acclimatized Victorian seed. The wisdom of this determination was proved subsequently by the results of experimental sowings of the New Zealand variety. At Drouin, at the same time and under similar conditions, an acre was sown with the New Zealand seed, and several acres with Victorian-grown seed; but whereas the latter produced one of the best crops in the district, the crop from the imported seed was of so little value as regards both fiber and seed that it was never harvested.

The 1918 Harvest

Owing to the exceptionally dry spring of 1918, the early anticipations of a record harvest were not realized, but nevertheless the average yield of flax was a satisfactory one. Appraisers were appointed at the time of harvesting to inspect and value each crop, and 1,800 tons were delivered for treatment at the various mills. As was inevitable in what was to many growers a new venture, the lack of the necessary experience militated in some cases against the best results being obtained, but the average price paid—£4 15s. ($23.12) per ton—is evidence of the comparatively high standard of the crop. The treatment of the flax at the mills was not completed before the end of 1919, but it was estimated that flax products to the value of approximately £23,000 ($112,000) would be obtained. It is more than likely that, with the experience gained in both the cultivation and treatment of 1918 flax, more profitable results will be obtained from succeeding crops.

*From the *Commonwealth Journal* of the Institute of Science and Industry.

As there was every indication of continued high prices for flax products, the flax committee had no hesitation in recommending the Commonwealth Government to extend the guaranty to the 1919 crop, to place the industry on a surer footing. At the same time, it was thought that, in view of the high returns received by farmers at present for other agricultural products, such as hay, potatoes and butter fat, the guaranty of £5 per ton was hardly sufficient, and an increase to £6 per ton was therefore recommended. The Commonwealth Government adopted the committee's recommendations, and subsequently an agreement was made with the Imperial Government for the purchase by the latter of the 1919 fiber on the same terms as previously given, viz., £170 per ton c.i.f.

THE 1919 CROP

The area sown in 1919 was approximately 2,250 acres, an increase of 50 per cent on the acreage of 1918. The cultivation of flax has been introduced into several new localities, 700 acres having been sown in the Sale and Thorpdale districts, while in the western and central districts many farmers are growing this crop for the first time on a commercial scale. Provision will have to be made for the treatment of crops in those districts where milling facilities are not now existent, and the establishment of flax mills on a co-operative basis seems to offer the most satisfactory solution.

While fully assured that the flax industry can be established in the commonwealth on a sound and profitable basis, the flax committee considers that the most effective means of doing so would be a continuance of the present system of commonwealth control. A recommendation, therefore, has been made by the committee to the government that a guaranty of £5 per ton for standard flax be given to growers for a further period of three years, and the matter is now receiving ministerial consideration.

British Plate Glass Industry

Probably none of the war-time industries of Great Britain has shown greater development or more progress than that of glass making. Most of the country's imports of plate glass were from Belgium, but British glass manufacturers are now making a concerted effort to capture this branch of the glass industry from that country. It is estimated that an average of four Belgian ships fully laden with glass of various kinds arrive at the London wharves each week.

In 1914 there were only a few companies in Great Britain making plate glass or optical and chemical glassware. Although several had been established for many years, they were regarded as inefficient and their output was small in comparison with the requirements of the home market. The cutting off of German and Austrian supplies caused a great revival in this industry and many plants were extended on more modern and scientific lines.

English glass makers have been slow to do away with the hand-made method of production, but they realize that if they are to hold the home trade and to eventually successfully compete in foreign markets they must produce on a large scale, which is only possible by the use of machinery.

According to an interview with G. Peters, managing director of the Willesden Glass Works Co. (Ltd.), which was published in the *Daily Express*, his firm has a capacity of 10,000,000 sq.ft. of glass a week and production is at 40 per cent less than Belgian manufacturers. These works were established just before the signing of the armistice, and it is now claimed that it is the second largest sheet-glass factory in Great Britain. The initial cost of the plant was £100,000.

Mr. Peters also said: "There is a world shortage of glass, and we are out to take our share in supplying it. We are following the Belgian hand-blowing system at present, because no machinery has yet been found to give superior results. This, however, is sure to come, and we shall avail ourselves of every development in this direction. Twenty-five per cent of our workers are Belgians. We are training up British workmen for the future by taking on only British boys as apprentices. These boys start right away at 10 pence an hour. Skilled glass blowers can earn from £12 to £16 a week. They are all on piecework and the day is of eight hours."

Quicksilver Produced in 1919

The production of quicksilver in the United States in 1919 was 21,348 flasks, according to F. L. Ransome, of the United States Geological Survey, Department of the Interior. This was a decrease of 11,535 flasks, or about 35 per cent, from the output in 1918. These figures may be slightly revised when the final returns for the whole year are in.

The production by quarters, for 1919, according to the latest revised figures, was as follows:

	Flasks of 75 lb.
First quarter	6,125
Second quarter	4,059
Third quarter	5,413
Fourth quarter	5,751
	21,348

The output for the fourth quarter of the year shows an increase of 338 flasks, or about 6 per cent, over that for the third quarter.

Of the output for the fourth quarter 4,213 flasks were reported from California, 1,032 from Texas, 462 from Nevada, and 44 from Oregon. The proportion for the entire year was: California, 14,941 flasks; Texas, 5,183; Nevada, 821, and Oregon 403. No production was reported from Idaho or Arizona. The number of mines reported as productive during the fourth quarter was eighteen.

The quicksilver reported on hand at the mines or in transit to market at the end of the year amounted to about 4,000 flasks.

The average monthly prices of quicksilver per flask in San Francisco in 1919, as quoted in the *Mining and Scientific Press*, were as follows:

January	$103.75	July	$100.00
February	90.00	August	103.00
March	72.80	September	102.60
April	73.12	October	86.00
May	84.80	November	78.00
June	94.40	December	95.00

These figures give an average price of $90. This price should yield a profit to those operators whose mines are favorably situated and who have ore that averages 8 lb. or more of quicksilver to the ton. It evidently is not enough under present conditions, however, to furnish much incentive to the working of the lower grades of ore to which many of the mines have been reduced, or to encourage very active search for new ore bodies of so capricious a mineral commodity as quicksilver.

Synopsis of Recent Chemical & Metallurgical Literature

Influence of Artificial Carburation of Coal Gas on the Crystallization of Naphthalene in Gas Pipings.—Accumulation of naphthalene in the pipe lines, especially during the cold season, is a very troublesome problem in the gas industry. Cases occur quite often when as much as 1 kg. of naphthalene is deposited per meter of piping (⅔ lb. per ft.).

The methods to separate the naphthalene at the gas plant are based mainly on:

(1) Rapid cooling of the gas leaving the hydraulic main, a method first suggested by Emile Saint-Claire Deville. Thus, when rapidly cooling the gases from its average temperature when leaving the hydraulic main 60 deg. C. (140 deg. F.) to below 20 deg. C. (68 deg. F.) about nine-tenths of the napthalene is condensed with the tar.

(2) By washing the gas after leaving the gas purifiers with heavy oils. This is based on the same mechanical principle as that used to wash the gas with water for the separation of ammonia (method first suggested by Dr. Buels). By this method all the naphthalene contained in the gas can be separated.

After separating naphthalene the candle power of the gas is diminished. This would not be detrimental to the consumer when the gas is used only for heating purposes. When the main use of the gas is for lighting, it is best not to separate the naphthalene, but to hold it therein in gaseous form even at low temperatures. This can be realized by artificially carburating the gas with hydrocarbons derived from oil of coal tar.

CH. AB-DER-HALDEN has made experimental studies on the effect of artificial carburation, and the results of his work are described in the January, 1920, issue of *Chimie et Industrie*. Tables and diagrams are given, which show the influence of the oil used for carburation, and which lead to the following conclusions:

(1) When a coal gas saturated with naphthalene at a given temperature is artificially carburated, it can be cooled below this temperature without the naphthalene solidifying, as it is retained in the form of a gaseous solution by the carburating vapors.

(2) The efficiency of the treatment depends on the boiling point of the carburating agent and not on its chemical composition, and the best results are obtained with oils boiling between 80 and 90 deg. C.

(3) The cooling point of the treated gas up to which the napthalene will not solidify out depends on the quantity of the carburating agent used.

(4) The influence of carburating coal gas supersaturated in naphthalene is the more marked the greater the contents of the naphthalene in the original gas.

Some Properties of Sodium Nitrite.—Sodium nitrite plays an important role in the synthetic manufacture of HNO_3. C. MATIGNON and Miss C. MARCHAL have studied some of its properties. (*Comptes Rendus*, vol. 170, No. 4, pp. 232-233.) They worked on a very pure product, analyzing 99.9 per cent $NaNO_2$ and have found the following results:

Fusion point, 276 deg. C.

Heat of Solution. Sodium nitrite dissolves with comparative ease, the molecular heat of solution is —3.52 cal. at 20 deg. C.

Heat of Neutralization. This has been determined by adding a calculated quantity of sulphuric acid to a dilute solution of the nitrite, and was found to be 4.6 calories on the average.

Heat of Formation. The above values added to the heat of formation of the nitrous acid as determined by Berthelot:

$$N + O_2 + H + aq = HNO_2 \text{ solution} + 30.3 \text{ cal.}$$

and to the thermal constants of soda and sodium oxide give for the heat of formation of the solid nitrite 88.52 cal.

$$N \text{ gas} + O_2 \text{ gas} + Na \text{ solid} = NaNO_2 \text{ solid} + 88.52 \text{ cal.}$$

Action on Colored Reagents. The action of nitrous and nitric acid with phenolphthalein, cochineal, lacmoid, paranitrophenol, brazilian and iodeosine is the same. Helianthine is destroyed by nitrous acid.

Action of Oxygen. Sodium nitrite solution cannot be oxidized directly, even when maintaining the solution at 100 deg. C. in contact with oxygen under a pressure of 50 and 55 atm. for 5 to 6 hr. and with continuous agitation. The same negative results were obtained by the use of an oxidizing catalyzer, such as platinum black.

Comparative Study of Electrically and Coke Heated Blast Furnaces. — The relative expenditures of heat and the compositions of gases obtained in electrically and coke heated blast furnaces have been studied by MARCEL GUÉDRAS and described in the Jan. 20, 1920, issue of *Revue de Métallurgie*. Tables I and II give respectively the data of the heat expenditure in an electric furnace at Trolhättan, Sweden, and in a 90-ton furnace using coke.

TABLE I. HEAT SPENT IN AN ELECTRICALLY HEATED BLAST FURNACE PER METRIC TON OF PIG IRON

	Calories.
Reduction of 91.02 kg. Fe from Fe_2O_3	163,836
Reduction of 873.118 kg. Fe from Fe_3O_4	1,440,648
Reduction of 3.110 kg. Fe from FeO	725
Reduction of 0.160 kg. Mn from Mn_3O_4	315
Reduction of 4.270 kg. Mn from MnO	7,387
Reduction of 3.420 kg. Si from SiO_2	26,779
Reduction of 0.186 kg. P from P_2O_5	1,096
Heat of fusion of iron and slag	402,400
Heat of decomposition of carbonates	49,134
Heat of vaporization of 87.38 kg. H_2O, less cooling to 60 deg. C.	53,479
Tensile heat of dry gases from 10 to 60 deg. C.	
128.01 kg. CO_2 ... 1,280	
591.36 kg. CO ... 7,229	
10.54 kg. CH_4 ... 314	
3.73 kg. H ... 640	
	9,463
Total	2,155,262

TABLE II. HEAT SPENT IN A COKE-HEATED BLAST FURNACE PER METRIC TON OF PIG IRON

	Calories
Reduction of 950 kg. Fe from Fe_2O_3	1,792,650
Reduction of 10 kg. Si from SiO_2	78,300
Fusion of 1000 kg. pig iron	300,000
Fusion of 1452 kg. slag	726,000
Decomposition of 1,170 kg. carbonates	438,750
Vaporization and heating to 250 deg. C. of 96 kg. H_2O	74,736
Decomposition of H_2O contained in the air used	19,320
Heat entrained by the gases	47,374
Losses	450,000
Total	3,927,130

In the electrically heated furnace the quantity of heat furnished per metric ton of pig iron is 2,155,262 calories, of which 908,830 calories are obtained by burning 34.91 kg. C to CO_2 and 113.44 kg. C to CO, leaving a balance of 1,246,432 calories to be supplied by electric

energy, corresponding to 1,454 kw.-hr. In the blast furnace 1,100 kg. of coke is required per metric ton of pig iron. The tables show that the heat spent in the blast furnace is 1,771,863 calories more than in the electric furnace. Improvements in the electric furnace construction and operation will certainly increase this marked difference.

The composition of the gases from the blast furnaces is:

	Blast Furnace Per cent	Electric Furnace Per Cent
CO_2	18.60	14.12
CO	22.15	83.00
CH_4	0.62	0.54
H	0.08	1.86
N	58.55	0.48

Their calorific heat is, in blast furnace, 638 calories; in the electric furnace, 2,257 calories. The amount of gas produced per ton of pig iron is, in the blast furnace, 5,615 kg.; in the electric furnace, 737.9 kg.

Expressed in calories the total heat values of the gases in the two types of furnace are respectively 3,582,370 and 1,665,485 calories. This shows an apparent advantage for the blast furnace, but as a matter of fact the electric furnace gas is superior and more useful than that from the ordinary blast furnace.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Halogen Substitution Products. — Oxidation and reduction reactions in the gaseous phase, such as the substitution of a halogen in gaseous carbon compounds, may be carried out in an apparatus devised by WILLIAM KOEHLER of Cleveland, Ohio. The gases are passed separately through nozzles so arranged that the streams of gas converge at a point beyond the nozzles. Thorough mixing results and an electric spark or arc is provided at this point so that mixing and heating to the reaction temperature are accomplished simultaneously, thereby preventing premature explosions of the mixture. (1,332,730; March 2, 1920.)

Nitric Acid.—A mixture of niter cake and sodium nitrate is passed through an inclined rotating kiln which is heated in a furnace in such a manner that the lower portion of the retort is subjected to the highest temperature. A sharp-edged iron bar is placed lengthwise in the retort, so that it tumbles about as the retort revolves and prevents the mass from adhering to the sides. A slow current of air through the apparatus effects the oxidation of the lower oxides of nitrogen and maintains the flow of the gases through the condensers and absorbers. (1,332,195; THOMAS F. BANIGAN of Kenvil, N. J., assignor to Hercules Powder Co., March 2, 1920.)

Naphthalene-β-Sulphonic Acid.—Sulphuric acid of 75 per cent strength is preferable to concentrated or fuming acid for the production of naphthalene-β-sulphonic acid. When sulphonation is carried on with this acid at about 160 deg. C. for a period of from 1 to 1¾ hr., the product contains only 22½ to 26 per cent of the α-sulphonic acid and very small amounts of sulphones, disulphonic acids and gum-like insoluble carbonaceous residue. The β-acid is preferably extracted from the mass by the use of toluene according to the method described in U. S. patent 1,228,414 of June 5, 1917, also granted to the present inventor, LOUIS M. DENNIS of Ithaca, N. Y. (1,332,203; March 2, 1920.)

Copper-Lead Smelting Process.—Methods by which complex ores carrying copper, lead and zinc can be economically treated for the recovery of the metals are of particular interest at the present time. As a general proposition, coke is expensive at mining centers, whereas soft coal may be relatively cheap and electric energy is usually available at a reasonable price.

WOOLSEY MCA. JOHNSON, of Hartford, Conn., proposes to take advantage of these general facts in a process for the recovery of copper, lead and zinc. The basic and acidic components of the charge to be smelted are heated separately in rotary kilns, using coal or coal dust for fuel. These are fed separately to an electric furnace in which the reduction takes place in such proportion that a slag of approximately the following analysis will result: SiO_2, 40 per cent; CaO, 20 per cent; FeO, 30 per cent, and ZnO, 10 per cent. In this operation lead bullion and copper matte will be produced in the same manner as in a lead blast furnace. The slag and matte are passed through two electrically heated settling hearths. In the first settler matte will be tapped out at intervals, while the slag, partly freed from matte, will pass to the second settler, where some fine carbonaceous material will be added to reduce the ZnO, and any dissolved PbO or CuO. In case much lead is present and in case an extremely high temperature is used, it is necessary to collect the lead fume from the electric furnace in a suitable apparatus. Also, in cases where no lead is present in the ore, the ratio of CuO to Cu_2S is so proportioned that the reaction $2CuO + Cu_2S = 4Cu + SO_2$ takes place, producing copper bullion directly from the ore.

It is evident that by this process but small amounts of electricity are used and that it plays a rôle similar to that of small amounts of coke in pyritic smelting. By employing indirect methods of heating, fine ore or flotation concentrates can be smelted without dusting. A representative slag will contain, it is claimed, less than 0.1 per cent of copper and lead, and not more than half an ounce of silver with no gold. If proper precautions are taken the electrode consumption is not over 4 lb. per ton of ore treated. (1,333,720; March 16, 1920.)

Electric Furnace.—A patent covering the design of a revolvable electric furnace has been granted to WILLIAM K. BOOT. This furnace was described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 21, p. 636, Nov. 12-19, 1919. (1,332,795; March 21, 1920; assigned to the Booth Electric Furnace Co., of Chicago, Ill.)

Recovery of Copper From Its Ores and Solutions.—H. LIVINGSTONE SULMAN and H. F. K. PICARD, of London, England, have been granted a patent on the above subject which is assigned to Minerals Separation, Ltd. One object of the invention is to precipitate copper from copper solutions obtained in metallurgical operations in an effective and economical manner, in the form of sulphide; a further object is to utilize this precipitation for improving the recovery of copper from its ores by the froth-flotation process of concentration as described, for example in U. S. Pats. 835,120, 962,678 and 1,064,723. The method consists in adding a precipitant containing ferrous and calcium sulphide to the copper-bearing solution and separating the copper

sulphide precipitated. The precipitant is produced by heating pyrites, or chalcopyrite, bornite, etc., with an equivalent of lime to a low red heat and cooling out of contact with air. (U. S. Pat. 1,178,191.) The effective use of this precipitant requires the presence of a definite quantity of sulphuric acid in the solution and a certain time factor for efficient use. Both the copper sulphide and any copper in the pulp will be floated. (1,333,688; March 16, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cellulose Ester Solutions.—The viscosity of solutions of nitrocellulose, acetylcellulose, celluloid and other cellulose esters is permanently reduced by heating the solutions, meanwhile preventing the escape of solvent, to a temperature between 60 deg. C. and the temperature at which the ester in question is decomposed. The temperature and duration of the heat are correlated; the longer the heating and the higher the temperature the more is the viscosity reduced. (Br. Pat. 136,141—1919; O. CARLSSON and E. THALL, Stockholm, Feb. 4, 1920.)

Toluene Sulphochlorides. — Toluene-o-sulphochloride is separated from mixtures with its paraisomer containing 60 to 70 per cent of the ortho compound by seeding the liquid mixture at about —6 deg. C. with a crystal of the ortho compound and removing the crystalline ortho compound which separates out. The initial mixture may be obtained by treating toluene with chlorsulphonic acid and crystallizing out a portion of the para compound at —20 deg. C. (Br. Pat. 135,987—1919; F. E. MATTHEWS and E. H. STRANGE, London, Feb. 4, 1920.)

Lactose.—In obtaining lactose from whey, the albumen is precipitated by metaphosphoric acid. The whey is concentrated in vacuo to about one-fifth of its bulk and then heated to about 70 deg. C. A portion of the albumen is thus coagulated and is removed by skimming or decantation. The metaphosphoric acid is then added and the resulting precipitate removed by filtration or settling. The lactose is then obtained from the clear liquid by crystallization in the usual way. (Br. Pat. 135,614—1919; G. MARTIN, Manchester, Jan. 28, 1920). The albumen may also be precipitated by tannic acid, mercurous nitrate, phosphotungstic acid or magnesium sulphate. (135,969—1919. Feb. 4, 1920.)

Phenol Aldehyde Condensation Products.—In the production of insoluble condensation products from phenol or its homologues and formaldehyde or its polymers in the presence of an alkaline accelerator, from 6 to 20 per cent of a vegetable fatty oil (castor, linseed, rape, cottonseed, etc.), or camphor oil is added, either to the initial mixture or after the first stage of the reaction; the product is finally hardened. The product so obtained is flexible when hot. (Br. Pat. 136,298—1919; F. J. ROBINSON, Cowley, Middlesex, and DAMARD LACQUER CO., Westminster, Feb. 4, 1920.)

Purifying Mineral Oils.—In the purification of mineral oils by sulphuric acid and alkalis powdered anhydrous alkali carbonate is used, preferably with calcium chloride or other drying agent, to give a perfectly dry oil. In an example, acid-treated oil, washed with hot water if it is desired to recover the sulphonic and napthenic acids, is decanted into a vat, heated to 58-70 deg. C. and agitated, while dry anhydrous sodium or potassium carbonate or ammonium carbonate or bicarbonate is strewn over the surface along with calcium chloride. The alkali sulphate, calcium chloride and excess of carbonate are allowed to settle and the oil then filtered. (Br. Pat. 136,169—1919; G. GRISARD, Basel, Switzerland, Feb. 4, 1920.)

Production of Ammonium Nitrate. — Ammonium nitrate is produced in the solid form by bringing together oxides of nitrogen, oxygen, water and ammonia under such conditions that the proportion of oxygen present is in excess of that required to convert the whole of the oxides of nitrogen into nitrogen dioxide, the proportion of ammonia is insufficient to react with the whole of the oxides or nitrogen, and the proportion of water is not in excess of, and is preferably equal to, that which is sufficient to convert the whole of the ammonia added into ammonium nitrate by interaction with the oxides of nitrogen and oxygen. In the case of gases containing about 10 per cent by volume of oxides of nitrogen, produced, for example, by the oxidation of ammonia, an amount of oxygen equivalent to three or four times that theoretically required to convert the whole of the oxides of nitrogen into nitrogen dioxide may be added. The oxygen may be added in the form of oxygen gas, air, or air enriched with oxygen, and the water should be in a finely divided state, for example as vapor or spray. (Br. Pat. 136,190—1919; J. R. PARTINGTON, of the Munitions Inventions Research Laboratory, University College, London, Feb. 4, 1920.)

Concentrating Ores. — The product obtained by treating a soluble soap or its ingredients such as sodium oleate with sulphur, or by treating a fatty acid with a soluble alkaline sulphide, or by adding a soluble soap to an aqueous solution of sulphuretted hydrogen, is used as the mineral-frothing agent in froth-flotation processes. The agent may be obtained by heating the soluble soap or fatty acid with the sulphur or sulphur-containing material, and may be used in processes of differential separation or in the concentration of sulphide or oxidized ores. In some cases acid may be added. (Br. Pat. 136,255—1919; S. TUCKER, E. EDSER and MINERALS SEPARATION, LTD., London, Feb. 4, 1920.)

Treating Ores. — Ores containing more than one sulphide are treated with a solution of a chloride (ferric chloride and manganese chloride being mentioned) which exercise a selective action leaving one or more sulphides, such as zinc sulphide undissolved, and dissolving other sulphides to form chlorides, such as lead, copper, silver and gold chlorides, with precipitation of sulphur. This precipitated sulphur may be separated from the undissolved matter by flotation, or may be left with the zinc sulphide, as it facilitates the roasting of this body and yields a gas richer in sulphur dioxide and suitable for the production of sulphuric acid. The metals contained in the solution may be separated in known manner; for instance, lead may be precipitated by iron, or electrolysis may be employed, or the chlorides may be crystallized. The ferrous chloride resulting from the process may be reconverted into ferric chloride by treatment with chlorine or with air in the presence of hydrochloric acid, or by evaporation to dryness and calcination, in which case ferric chloride sublimes, leaving a residue of ferric oxide. (Br. Pat. 136,163—1919; SOC. ANON. MINERAIS ET MÉTAUX, Paris, Feb. 4, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Republican vs. Democrat on the Nitrate Program

FURTHER expenditure of funds by the War Department on the Muscle Shoals Nitrate Plant should be discontinued, in the opinion of the majority of members of the select committee of the House of Representatives, which has been investigating the matter. However, the minority is unable to agree on this point; in fact the committee is hardly able to agree among themselves on any point. For instance, the majority damns the Air Nitrates Corporation, while the minority as stoutly upholds the Air Nitrate Co.—presumably the same organization! Briefly, the majority condemns the nitrate program as a waste of effort directed by B. M. Baruch at the instigation of Washburn, Worthington, et al., who were to profit from it. They also contend that Chilean nitrate should have been relied upon to make up any deficiency from coke ovens; that the plants were improperly located, extravagantly built, following processes which would either not work or should be promoted by private enterprise. Opponents to the Government program were disciplined during the war, and now the Ordnance officers who directed the construction are held up for severe censure. Muscle Shools, if operated, should produce fertilizer nitrogen, yet the men in charge are held culpable for completing the work, acquiring operating power and a lime quarry. In general, it was a sad débâcle and should be abandoned immediately! Reverse all these ideas, and the reader has the minority view.

The committee agrees that Plants 3 and 4 should be salvaged, that the Alabama Power Co. took unfair advantage of the Government's need of power, and that the Wilson Dam will require $12,000,000 for completion.

As to the disposition of the Muscle Shoals plant, the minority holds that this is covered by a pending bill in Congress and declines to discuss the majority recommendation that it be leased under restrictions for private operation.

Program's Contribution to Victory

1. The majority finds that there has been expended for construction upon the Government's nitrate program to the present time the sum of $116,194,974.37, and that this expenditure produced no nitrates prior to the armistice, and contributed nothing toward the winning of the war.

The minority grants that no nitrates were produced at these plants prior to the armistice, but utterly disagrees with the statement that the expenditures contributed nothing to the winning of the war. If the expenditures for the war program are to be criticized, or their necessity or non-necessity judged because hostilities came to an end unexpectedly in November, 1918, then probably three-fourths of the nation's efforts were useless.

Activities of Baruch

2. According to the majority, the nitrates program originated with the War Industries Board of the Council of National Defense, and is directly traceable to Bernard M. Baruch, chairman of that board.

On the other hand, the Democratic view holds that the nitrate program grew out of the necessities determined by the Gun Division to be essential according to the number of divisions which the General Staff planned from time to time to put into the field. Mr. Baruch played a most important and highly praiseworthy part.

Was Nitrate Program a Misdirected Effort?

3, 4, and 5. The Republicans hold that had the labor and money required to construct the nitrate plants been utilized in producing food or other war essentials, real assistance would have been rendered in winning the war. In June, 1916, Congress appropriated $20,000,000 for the manufacture of nitrates, then the policy of neglect, delay and do-nothing was followed in that regard by the President and the War Department until the late fall of 1917. Had the War Department, early in 1916, purchased and stored in this country large quantities of Chilean nitrates as was advised by General Crozier to the Secretary of War, the only excuses for the building of Government nitrate plants in the late fall of 1917 would be lacking.

The minority charges inconsistency in these three allegations, which are said to be the fundamental principles of the majority report. In substance, paragraph 5 criticizes the President of the United States for not, while we were at peace, hastily embarking upon a war-supply program, which paragraph 4 declares was, when embarked upon after we had gone into the war, "one of misdirected effort," and for which paragraph 6 declares there "was no national necessity at any time." Chilean nitrates could not be purchased on account of lack of funds, and its storage would have embarrassed the explosives program of England and France. The majority omits to state that at the very same time, in 1915 in fact, General Crozier was investigating the subject of nitrogen fixation and recommended the development by the Government of such processes along with the purchase of Chilean nitrates.

Possible Reliance on Chilean Nitrate

7, 8, and 9. These findings contain allegations by the majority that submarine menace and probable high price were not valid reasons for abandoning reliance on Chilean nitrate which, barring coke-oven nitrogen, comprised our entire supply and was able to build up a reserve of 600,000 tons despite our war requirements.

The minority contends that the submarine was a real danger to our supply, and cites the following additional reasons for an internal supply: (*a*) Shortage of ships. (*b*) Need of ammonia as distinguished from sodium nitrate. (*c*) Large but unknown naval requirements. (*d*) Requirements of Allies. (*e*) The propellent requirements as distinguished from explosives. These consisted largely of smokeless powder, for the production of which immense quantities of nitrogen must be had. (*f*) Cumulative demand for nitrogenous fertilizer. As a matter of fact the 600,000 tons was less than two months' supply at the then rate of manufacture.

10. The whole committee reaches approximate agreement that as a result the United States has the following nitrate plants finished or partially finished:

(*a*) Experimental Nitrate Plant No. 1, at Sheffield, Ala., constructed for the manufacture of nitrates by the General Chemical Co. process, at a cost of $12,152,636.91, which plant is supposed to be completed. As pointed out in the minority report, the nitrate feature of Plant No. 1 at Sheffield constituted but one of its units, and it is the only unsuccessful part. This unit was to produce ammonia. It cost $5,502,170.13, including its proportion of overhead expense.

(*b*) Plant No. 3, partially constructed plant at Toledo, Ohio, which cost $7,781,609.06.

(*c*) Plant No. 4, near Cincinnati, Ohio, partially constructed, at a cost of $7,578,229.84.

(*d*) Plant No. 2, at Muscle Shoals, Ala., completely constructed for the manufacture of nitrates by the cyanamide process, at a cost of $69,985,221.42.

(*e*) In addition to the foregoing, the Government has made an expenditure of $5,167,277.42 upon the property of the Alabama Power Co.

(*f*) A quarry site in northern Alabama which cost $60,000.

(*g*) An unfinished dam on the Tennessee River at Muscle

Shoals, Ala., for which there has been allocated $13,170,000, and which, to complete, will require approximately an additional $12,000,000, but according to Democratic view, the dam has only the remotest connection with the nitrates program.

Location of Plants

11. Blaming the President for ill-advised choice in location of the plants, and particularly for ordering the Wilson Dam at a time when he must have known it could not be completed with the funds available for that purpose, and that it could not be completed in time to be of service during the war, the majority view, is countered by the minority's statement that the President and the Secretary of War, either together or singly, may safely assume this responsibility without apology and without it adding to their burdens. They also call attention to the fact that the Wilson Dam was not a war project, in the sense that it had any bearing upon or connection with the war with Germany.

Opponents to Program Disciplined

12. In the words of the minority, the majority's assertion that anyone who opposed or sought to modify the plans of the President and Secretary of War for the development of Muscle Shoals was either disregarded or disciplined is wholly gratuitous. Colonel Hugh Cooper's recommendations as to the Muscle Shoals dam were largely carried out, and a transfer to be Base Engineer at Bordeaux could hardly be regarded as a demotion. No hint was heard that Dr. Charles L. Parsons was disciplined for his opposition to the location of Plant No. 2. His advice upon matters was freely given before and after that time, sometimes acted upon and sometimes not.

It was partly upon Dr. Parsons' recommendation that the Experimental Plant No. 1 (General Chemical Co.'s process) was established, the plant which failed to function. He is a believer in the future great possibilities of the pressure process in competition with other processes and is, as he frankly told the committee, personally interested now in a business way in its development. He was not so interested at the time of his recommendation. We do not deem it any reflection upon Dr. Parsons that the Experimental Plant No. 1 has not yet in its ammonia unit been successfully operated. He had data sufficient to justify the recommendation and the authorities were justified in following it.

Blundering Trial of Haber Process

13. The majority refers to the expenses incurred at Plant No. 1 (modified Haber process) as a colossal blunder and waste of public funds. While the minority admits that too expensive construction was provided, especially in living quarters, they feel that a venture with a process which gave Germany one-third her nitrates during the war was well advised. The General Chemical Co. had carried on laboratory experiments which had been sufficiently satisfactory as to cause it to determine to go into the business commercially, and it was preparing to expend an immense sum of money in the construction of a plant, and had expended about $500,000 assembling materials when the Government became interested. The enterprise was undertaken, admittedly as an experiment, upon the recommendation of eminent scientists, including Dr. Charles L. Parsons, of the Bureau of Mines, who had made exhaustive studies of the various methods in use in the European countries for nitrogen fixation.

Influence of Washburn and Worthington

14, 15, and 16. The minority declares to be wholly misleading the majority's finding that the building of Plant No. 2 at Muscle Shoals was the deciding factor inducing the building of the Wilson Dam—a culmination of years of effort and striving of Washburn, Worthington and others to induce the National Government to dam the Tennessee River for the production of hydro-electric power at Muscle Shoals, a hydro-electric development redounding to the profit of various interests of these two men.

Colonel Joyes Upheld by Minority

17 and 18. The two contracts made by the War Department with the Air Nitrates Corporation, the first being dated Nov. 16, 1917, and the second June 8, 1918, are unilateral and unfair and unjust to the Government. The Ordnance officers, charged with responsibility, failed in most instances to guard the interests of the United States in the contracts for the construction of the nitrate plants. In particular, Colonel J. W. Joyes deserves severe censure for signing the second contract, for purchasing chemical equipment for twice its market value, and his zeal in carrying out the agreed program after the armistice had been signed.

On the other hand, the minority states that it is not correct that the Ordnance officers charged with responsibility failed in most instances to guard the interests of the United States in the contracts for the construction of the nitrate plant and they repudiate emphatically the assertion that Colonel J. W. Joyes merits censure. This faithful officer of the Regular Army, denied the opportunity of serving on the battle line because he was needed here, has rendered to his country, in a position of gravest responsibility behind the lines, a service which entitles him to the praise and honor of his countrymen. Working under the most extreme difficulties, having upon him a very large degree of responsibility for furnishing the munitions upon which success depended, he has acted upon principles of the highest integrity and with commendable prudence. He was not satisfied with the terms of all the contracts which he was compelled by circumstances to enter into. It was a matter of bargaining for things which the Government absolutely had to have and which those with whom he was dealing knew it had to have. That he succeeded, as the record shows he did, in again and again securing modifications of proposals, every such modification being in the interest of the Government, at a time when the cry from everywhere was "speed" and "still more speed," and those with whom he was dealing knew it and knew that they held practically both ends of the string, does greatest credit to his industry, his powers of persuasion, and his patriotism.

Misuse of Appropriations

20. In the opinion of the majority, the funds used to construct Nitrate Plants 2, 3 and 4 were taken from the said "Armament of fortifications (C)" fund, not contemplated by Congress to be used for such purposes.

The minority appear surprised at this statement and understand the assertion to be merely the opinion as to the ignorance of Congress. The terminology "Armament of fortifications (C)," which has been carried in the fortification appropriation bills for long years, they thought had been thoroughly understood by members of Congress, at least. It is the item from which funds have been all along derived by Ordnance for its needed munitions and all the processes essential to obtain them, except a certain amount carried in the fortifications bill under the terminology, "Practice and field artillery ammunition."

Collusion at Muscle Shoals

21. It is obvious to the majority that the War Department forced the completion of this work after necessity had vanished. When hostilities had ceased, an uncompleted steam power plant costing $10,000,000 was rushed to completion; the Waco quarry has been acquired and $60,000 has been expended for land for the same; a modern electric plant, industrial village, transmission lines, and railroads have been completed for the Alabama Power Co. at a cost of over $5,000,000, while work on the Wilson Dam, which had been suspended by the Priorities Board, when it was known an armistice would be signed, on Nov. 9, 1918, was ordered recommenced and rushed.

In the minority view it appeared natural that the War Department was intensely interested in having this magnificent plant 100 per cent complete, because it is without a doubt the nation's greatest material military asset. The manufacturing part of this plant, having a capacity of 110,000 tons per annum of ammonium nitrate, was completed to the point where it was ready to be put into successful operation. The steam-power plant had reached a stage of completion that made it wise business economy to finish it, rather than to leave it standing as a useless ruin; practically all of the machinery had been ordered and commitments were outstanding. As to the other matters, the Government carried out its pre-existing contracts. As for the dam, let it be clearly understood that the President of the United States directed this dam to be built in accordance with the duty imposed upon him by the national defense act of 1916. That dam is for peace uses as well as war uses. It is expressly so stated in the law itself and was so interpreted in practically every argument made upon it in the House and Senate by friend or foe while the legislation was being considered. The hydro-electric power to be there created is to be used by the very terms of the law itself for the making of fertilizer in times of peace and munitions in times of war.

Location of Plants Nos. 3 and 4

22 and 23. The majority holds that the location of Plant No. 3, at Toledo, Ohio, was entirely unsuitable for such a plant, it being surrounded by water and otherwise largely inaccessible. The site selected for Nitrate Plant No. 4, in the Little Miami Valley, near Cincinnati, Ohio, was equally unsuitable, in a locality where construction was costly, labor hard to accommodate, and with high prospective expense for transportation of raw materials. It seems that

they were located in Ohio because a Congressman needed to distribute a certain amount of pork.

However, the minority again finds itself unable to agree with the majority. After some remarks about 1861, it states, so far as the record is concerned, the controlling element in locating Plant 3 at Toledo and Plant 4 at Cincinnati was the fact that there was available at these two cities, and could be secured from facilities already in existence, large blocks of power not elsewhere procurable and absolutely indispensable, a question of very great importance in the war activities.

In justice to the Ohio Member of Congress who has criticized the construction of Plant No. 2, it should be said that his criticism was not leveled at the place—Muscle Shoals—but at the construction of a plant for nitrogen fixation by the cyanamide method anywhere, he, like Dr. Parsons, being a believer in the Haber plan or in one of its modifications.

Was Construction Wasteful and Poorly Executed?

24, 25 and 26. The cost-plus system adopted by the Ordnance Department is, in the majority's view, unduly expensive and demoralized the country's labor. Waste of labor and material was rampant which under ordinary circumstances would approach criminality. Particularly the Air Nitrates Corporation was extremely faulty and inefficient in organization and experience.

In view of the necessity of haste, the impossibility of preparing final and complete plans, and the general instability of materials and labor markets, the minority contend that the cost-plus system was the only practicable method of construction. Some leading contracting firms, whose integrity is above all suspicion, use it almost exclusively, and have for years. The sworn testimony of responsible officials of the Air Nitrates Corporation is to the effect that the costs of labor and materials upon the whole job were in the ratio of 34 per cent to 66 per cent—that is, 34 per cent of the total cost was for labor and 66 per cent for material. It is understood that the usual proportion is 40 per cent to 60 per cent. It is further testified to that there has been an inventory taken with the most painstaking care of every item in every structure and this checked with the invoices paid, with the result that there is shown a deficiency or loss of material of 1.61 per cent.

Air Nitrates Entered Into a Trust Relationship

27. Both parties agree to this item, the minority, however, disclaiming the inference that the principle has been violated. By the contracts between the Air Nitrates Corporation and the United States the Air Nitrates Corporation became the agent of the United States, and hence the relation between that company and the Government was of a fiduciary character, a trust relation which required the utmost good faith and reasonable diligence in protecting the interests of the Government from the destruction and waste of its property by its employees and subcontractors. Complete settlement has not been made with the Air Nitrates Corporation by the Government on account of these contracts.

Shall the Government Operate Muscle Shoals?

28 to 37. The majority believes that it is for the best interests of the country and for the public welfare that there be built up in the United States a nitrate industry by private initiative and capital, capable of supplying the wants of our people for fertilizers in times of peace and explosives in times of war. If a governmental agency should engage in the commercial manufacture of nitrogen compounds for sale, it would discourage and retard this development. Consequently it would be unwise for it to build and operate a plant in conjunction with Nitrate Plant No. 2, at Muscle Shoals, for the manufacture of ammonium sulphate and other nitrogenous compounds for commercial purposes. Furthermore, the disposition of such byproducts as lime and crushed rock would destroy private business in these lines within a radius of 200 miles. However, if Muscle Shoals plant should be operated at a low cost and produce annually 86,000 tons of ammonium sulphate, such amount would be so inconsiderable, in comparison with the total amount required in the United States for all purposes as to make little or no appreciable reduction in the price of agricultural fertilizers. Still, even this amount would not be salable since the quantity produced by the byproduct coke ovens is largely in excess of any amount of ammonium sulphate ever used heretofore in the United States for agricultural purposes. There are 11,000 of these ovens now in operation, 1,500 of which were constructed by Government funds, and the majority is loath to prevent further conservation of natural resources by the supplanting of beehive by retort ovens by appearing to compete with them for the ammonia market. Notwithstanding the fact that the majority calls a governmental experiment in the Haber process a blunder, it understands that private enterprise is now formulating plans for the commercial manufacture of fixed atmospheric nitrogen by the Haber process. They admit for their present argument that it is generally known that the Haber process is much more economical and efficient in operation than the process now used at the Muscle Shoals plant, and that every reasonable encouragement should be given private enterprise. Private enterprise would hesitate and in all probability cease its intention of entering into a business in which any agency of the Government was to compete with products from a plant or possibly a chain of future plants built by Government funds and maintained by the National Treasury and not subject to limitations of the national defense act. On account of the character of Nitrate Plant No. 2 at Muscle Shoals, if it was salvaged the Government would hardly be recompensed for the expense of salvaging it. Three feasible plans for the future of this plant are presented: First, that the plant be kept in a standby condition; second, that it be leased to and operated by private enterprise, with such reservations in the lease as shall reserve to the Government the right to use it in the event of war with reasonable reservations as to price regulation by the Government, and with the further reservation that the product be offered in the general market so that it can be purchased direct by the consumer, including the farmers of the United States, and the majority finds that such a lease can be made; third, that it be operated by the Government.

All these questions the minority dodges on the basis that it is an adverse report upon a legislative proposal now pending, not before the select committee but before the Committee on Military Affairs of the House, to wit, a proposition to install at Nitrate Plant No. 2 the necessary equipment to extend a portion of its units so that ammonia sulphate, which is a desirable form of ammonia for fertilizer purposes, can be produced, and to organize a Government-owned corporation to operate it and sell this product into commerce.

Abandonment of Plants 3 and 4

38. Here the committee seems to be as a unit that these plants should be salvaged as soon as possible, and proper settlements made of all claimants without protracted delay.

Equipment of Waco Quarry

39. The minority, on the same grounds as cited in 28-37 above, declines to discuss the recommendation that it would be unwise for the War Department to attempt to develop the so-called Waco quarry, and that no further expenditures should be made until some policy as to the future of the Muscle Shoals plant shall have been adopted by Congress.

Contract With Alabama Power Co.

40. An expenditure of over $5,000,000 for development of the property of Alabama Power Co., in the opinion of the majority, was unjustifiable and unnecessary, and the same results might have been accomplished by a loan of less than half this amount. The result of this expenditure has been to build up the property of a private corporation and establish it as a power monopoly in northwestern Alabama.

This contract is not upheld by the minority. So far as the record goes the Alabama Power Co. does not stand in a favorable light therein. The conclusion cannot be escaped in the light of testimony that at some stages of the proceeding the company appeared to have imposed upon the Government's necessities and unduly forced increases in certain of its facilities. The contract with this company and various things done in its execution were not satisfactory to the contracting officer in all their phases. It was simply a case where he did the best he could. The pressure was insistent, growing out of public necessity for getting the plant into operation, to begin producing explosive material for the expected 1919 military campaign. The steam power plant could not be gotten ready in time to coincide with the manufacturing part of the enterprise, nor could the dam at Muscle Shoals. At the time the first proposition of this company was submitted to Colonel Joyes, suggesting a Government loan to it of $2,250,000, there was no authority of law to make loans to private industry. The statement is incorrect, that the same results "could have been attained by a Government loan of half the amount."

Wilson Dam Requires 12 Millions More

41. The whole committee finds that the Muscle Shoals Dam, without the building of at least two other dams, will not improve the navigability of the Tennessee River. That to complete the Muscle Shoals Dam will require an additional appropriation of approximately $12,000,000.

The bulk of the majority's report thus appears to be a criticism of the nitrate program, a plan of action formulated under great stress of urgency and in the face of almost complete technical ignorance. Its greatest defect in their eyes was enough to spoil its every deatil, and that defect was primarily due to the fact that the war ended too soon! Yet they are as unable to recommend a constructive future policy as they are of finding good in whole-hearted effort. Granted that we had no commercial plants for the production of synthetic nitrates before the war, and that that lack then cost time and money, by all means let us now throw away the chances we have of systematically acquiring this knowledge.

Divergent Recommendations of the Committee

Majority Recommendations

1. The committee recommends that no further sums of money be paid the Air Nitrates Corporation or its subcontractors on account of its various contracts for the building of Nitrate Plants Nos. 2, 3, and 4 at this time, but that all sums claimed to be due and owing by the Government be retained; that civil suits be instituted against the Air Nitrates Corporation by the United States to recover such sums as shall reasonably compensate the United States for the failure of the Air Nitrates Corporation to perform its said contracts, or that the said Air Nitrates Corporation be compelled to sue for recovery in the Court of Claims, or other proper forum, where the Government may, by set-off, counterclaim, or recoupment, litigate the matters herein mentioned, or that the United States pursue such remedies concurrently, as may be decided by the Attorney-General of the United States.

2. The committee recommends that the materials stored by the Government in Nitrate Plants Nos. 3 and 4 be at once removed to other storehouses of the Government, that said plants be, as soon as possible, salvaged and sold to the best advantage, and that all landowners who have not been paid for lands purchased, taken, or damaged for said plants be compensated for the same.

3. That Nitrate Plant No. 1 be kept in a standby condition for the present with a sufficient force to guard and maintain the same, subject to such experimental use thereof, from time to time, as is necessary in developing nitrate processes or perfecting the said plant. That 1,200 acres of land not now used in said plant be sold at its fair market price; that the houses built in connection with said plant, where the same are not used to house officials or employees of the United States, be leased at fair rentals, notwithstanding the opposition of the Sheffield Chamber of Commerce or any other body.

4. Your committee recommends that Nitrate Plant No. 2 be leased by the War Department on such terms as will secure its continuance as a plant capable of producing fixed atmospheric nitrogen, and with reservations permitting the use of the same by the Government in time of war or threatened war, reserving to the Government a reasonable regulation of prices, and providing for the sale of the product on the general market direct to the consumer, including farmers in the United States, and that if this cannot be done, that the plant be kept in a standby condition until Congress shall determine upon a policy as to the future of said plant.

5. That no further funds should be expended by the War Department on the Muscle Shoals plant, and no further appropriations for alterations, changes, or additions to said plant should be made by Congress for the use of the War Department or any agency of the Government acting under or through said War Department, until some policy as to the future of said plant shall be determined upon by Congress.

Minority Recommendations

1. Not having any exact knowledge from the testimony adduced of the status of the settlements or negotiations looking to a settlement of the contracts with the Air Nitrate Co., having no definite information of the claims and counterclaims of the parties thereto, we do not feel ourselves to be in any position to offer any intelligent advice as to their settlement or as to the procedure that should be followed by the War Department or the Department of Justice. We are content to leave this executive matter to the executive departments whose duty it is to attend thereto, and direct our attention to the performance of our own duties in the legislative branch. Should occasion arise for the exercise of the constitutional powers and duties of the legislative branch, we shall try to inform ourselves and aid in the way that may seem to us to be the proper exercise of those functions.

2. There is nothing in the record nor have we any information from any extraneous source, upon which we are able to predicate any advice as to the removal of the materials now in storage in the buildings at Plants 3 and 4. Whether the Government has other storage facilities that can be economically utilized, we have no idea, nor have we any information whatever as to the costs that would accrue for freight, handling and other necessary activities incident to removal. We see no necessity for any recommendation as to an action concerning the matter, particularly since we have no information of the various elements involved.

We have heretofore concurred in a measure with finding 38, touching the matter of salvage and sale of plants 3 and 4, and have stated our belief that any legal obligations of the Government relative to the lands and landed rights acquired by it, if any are still outstanding, should be liquidated and paid. We have no reason to assume that this will not be done or that any recommendation is necessary or within the duty of the legislative branch of the Government. Whatever of appropriation may be necessary for the discharge of the Government's obligations will, we assume, be properly brought before the House by the Appropriations Committee.

3. There is no objection upon our part to the opinion implied in recommendation No. 4 as to what should be done with Plant No. 1, nor with the lands and houses, so far as we are informed of the facts. The 1,200 acres of surplus land, much of which was secured in contemplation of the erection of a powder plant, appears to be fairly good land for farming purpose and, so far as we know, the Government has no present need for it. These lands were acquired at a very reasonable price, some of them being donated outright. What the market conditions are now we do not know. Good business judgment should be used in disposing of them, as it doubtless will be.

We see no very serious objection to the renting temporarily and until other disposition can be made of the houses built in connection with the plant not in use by officials and employees. Just how Uncle Sam may get along as a landlord we do not know, but he is a very versatile gentleman, capable of doing many things and doing them well.

We have no sympathy with the implied criticism of the Sheffield Chamber of Commerce for opposing this, if they do in fact oppose it, which we do not know as a fact, though we believe there was some intimation to that effect somewhere in the hearings or stated privately to the committee. Those at Sheffield who have properties for rent probably fear Government competition with non-taxable real estate upon which the people carry the insurance and are probably in the same mental attitude toward it as are the private producers, present and prospective, of fixed nitrogen toward the operation by the Government of Nitrate Plant No. 2, for the production of commercial fertilizer.

We see no occasion for any recommendation.

4 and 5. Recommendations 4 and 5 involve directly the legislative question discussed in the findings 28 to 37, inclusive, and 39, with regard to the future use of Nitrate Plant No. 2, and for the reasons there stated, the minority deem it improper to here discuss them.

Research Council, Chemical Division, Annual Meeting

The annual meeting of the Chemical Division of the National Research Council was held in Washington May 7 and 8. The first order of business was the election of officers and members for the ensuing term. The results of the elections were as follows: Chairman of the Division, F. G. Cottrell, of the Bureau of Mines; vice-chairman, Julius Stieglitz, of the University of Chicago; members of the executive committee, C. L. Alsberg, Bureau of Chemistry; A. B. Lamb, Harvard University; John Johnston, Yale University; W. D. Bancroft, Cornell University. The other members of the Division are: C. G. Derick, National Aniline & Chemical Co.; J. M. Francis, Parke, Davis & Co.; E. C. Franklin, Stanford University; Colin G. Fink, Chile Exploration Co.; A. V. Bleininger, Washington, D. C.; Charles H. Herty, New York; W. F. Hillebrand, Bureau of Standards; G. A. Hulett, Princeton University; Hugh K. Moore, Berlin, N. H.; Arthur A. Noyes, California Institute of Technology; Charles L. Parsons, Washington, D. C., and J. E. Teeple, New York.

Charles L. Parsons was appointed a delegate to represent the National Research Council at the meeting of the International Chemical Union to be held at Rome, Italy, in the last week of June.

Reports of Committees

A very comprehensive report on the activities of the committee on explosives was presented by Charles E. Munroe. Among the important problems investigated were: Corrosion of Rifle Bearings; Products of Combustion of TNT; Desensitizing of Explosives for Storage; Hexanitrodiphenylamine; Use of TNT in Blasting. Furthermore, considerable time has been spent on the index to the literature of explosives which will soon be completed.

The report of the committee on synthetic drugs was presented by Prof. Stieglitz. It was pointed out that a number of important synthetic drugs had been placed on the market during the course of the year. Dr. H. N. Holmes told of the activities of the committee on colloids. The outstanding feature in this report was the remarkably efficient method the committee resorted to in educating students and the public in general to the vast importance of colloid chemistry. Lectures, both scientific and popular, had been delivered in most of the large towns of the country before enthusiastic audiences. Nearly every chemical industry in the country is confronted with colloid problems, for example, the rubber industry, dyes and dyeing industries, ceramic, glass, oil, pharmaceutical products, yeasts, etc.

Progress in Various Fields

Dr. Bleininger reported upon the researches in ceramics. There are many basic problems still waiting for a satisfactory solution. For example, there is the problem of finding a suitable refractory for glass pots which will not be readily corroded by the molten glass. A fellowship was established recently at the University of Illinois; the research will be confined largely to the "Viscosity and Electrical Conductivities of Glasses."

Dr. Derick discussed the progress made in the methods of analytical organic chemistry. The importance of the introduction of physicochemical apparatus into organic laboratories was particularly emphasized. Dr. Bancroft reported upon the progress made on research in contact catalysis. Important investigations are being carried out at seven of our large university research laboratories. Hugh K. Moore submitted a detailed account on the activities of the committee on the international tables of constants. The revision of our patent laws was discussed by Messrs. Cottrell and Francis.

Problems Awaiting Solution

Dr. Bancroft, after summing up the work of the Division during the past year, presented to the members a most remarkable collection of problems of far-reaching importance that are patiently awaiting solution. To those who have had difficulties in finding suitable problems for research, it will be a startling revelation to look over the list prepared by Dr. Bancroft. There are significant lines of chemical research to be found in every industry and profession of the country. The most promising field of research appears to be the borderland. Let the chemist co-operate with the geologist in studying the origin and formation of petroleum, or why some clays are plastic and others are not. Let the chemist work hand in hand with the biologist in investigating nutrition problems. There are many vital problems of mutual interest to both physicist and chemist; there are others on the borderland of chemistry and medicine. "And why should the chemist develop the borderlands? It is because the chemist has had the best all-around training."

Public Utility Power Efficiency

The monthly reports of the U. S. Geological Survey show a very interesting relationship between the power production and the efficiency with which the fuels are used in the various public utility central stations throughout the country. The following tabulation shows the total power output and the efficiency expressed in kilowatts per ton of coal used, for each of the seven months for which reports have been made. Some of the variation is undoubtedly due to seasonal factors, but the principal factor is probably the greater percentage load factor during recent months as compared with the period about a year ago. These figures, of course, cannot be taken as absolute in their significance, but are a good indication of the general practice.

Month.	Millions of kw.-hr.	Efficiency. Kw.-hr. per ton of coal.
February, 1919	1,834	586
March, 1919	1,842	580
April, 1919	1,718	594
July, 1919	1,929	636
October, 1919	2,240	645
January, 1920	2,575	643
February, 1920	2,327	632

Another interesting point shown by the figures is the relatively greater average efficiency of central stations in states where most of the power is generated at large plants. For example, in Pennsylvania, Illinois, Ohio and other states where large cities predominate, the efficiency is about 600 kw.-hr. per ton of coal or even higher, being nearly 800 in the case of New York and Michigan. On the other hand, in more sparsely settled states, such as North Dakota and Montana, the average is only 150 to 200 kw.-hr. per ton. This is a striking illustration of the large advantage which the proposed super-power plants, if installed, will have in substituting for existing central stations. When it is seen that the average for whole states is five times that for other states, one can readily believe that the estimated saving of 50 per cent of the coal now used in all central stations would be feasible if all were replaced by a super-power system.

Proposed Fertilizer Regulation

Gilbert N. Haugen of Iowa, chairman of the House of Representatives Committee on Agriculture, has proposed a bill entitled "United States fertilizer act" for fixing the standard, labeling, and marketing fertilizer.

In this act the term "fertilizer" is defined as "Any substance, including any combination or mixture, designed and fit for use in inducing increased crop yields when applied to the soil," but does not include animal manure in its natural or unmanipulated state.

In it the Secretary of Agriculture is empowered to establish standards for grades of fertilizers by which its quality and condition may be determined.

Invoices and container labels are to be marked with:

Name and address of manufacturer.
Net weight in pounds.
Per cent by weight of available N_2, P_2O_5 and K_2O.
Name of each ingredient carrying available N_2, P_2O_5 and K_2O, and the proportion of each such ingredient if more than one be included.
Percentage weight, and kind of each ingredient having fertilizer value other than ingredients containing available N_2, P_2O_5 and K_2O.
Grade of fertilizer compared to U. S. standard.
Other facts to prevent frauds.

After defining the matters of standards, labeling, information regarding bulk shipments, etc., the act proceeds to define the terms "misbranding," "adulteration," etc. Authority is given to the Department representatives to enter and inspect any factory or storehouse and to investigate any books or records of the fertilizer industry. The companies are also required to preserve full and accurate records and to answer any inquiry that duly accredited representatives of the Department may submit. It is also provided that the information secured through the operation of these inspectors, with the exception of "secret processes or formulas," shall be available for the use of either house of Congress at its request, and the Secretary of Agriculture is given authority to cause such information to be published from time to time.

Judging from the difficulty encountered by the Government in fixing standards on grain and enforcing other such laws, serious apprehension exists on the fixing of standards on fertilizer. Moreover, the multiplicity of different brands (208 being listed in a single state report, all having the composition of 10 per cent phosphoric acid, 2 per cent ammonia and 2 per cent potash) and the fact that they are taxable have led to a system of registration and inspection fees imposed on the industry by different states whereby the states derive a considerable revenue. In fact, many of the state colleges and agricultural schools which now are either entirely or partially supported from this income would be seriously crippled were this revenue cut off.

Uniformity of requirements and labeling would protect the consumer against fraud and assure him a product of known standard strength. It would also tend to decrease the needlessly large number of brands, in which there is not enough difference in composition to affect plant growth seriously. Manufacturers of fertilizers who now have difficulty in doing an interstate business, because of complexity of regulations, would also be enabled to carry on their trade with greater ease.

On the other hand, the passage of this bill would mean a heavy financial loss to those institutions which derive a considerable income from taxes on fertilizers as now sold, until many state laws could be properly amended.

National Fire Protection Association Meeting

At the twenty-fourth annual meeting of the National Fire Protection Association held in Chicago May 4 to 6, 1920, the committee on hazardous chemicals and explosives presented a report covering regulations for the storage, handling and use of pyroxylin plastics in factories making articles therefrom. The report covered these substances, whether used in the form of raw materials, stock in the process of manufacture, unfinished or finished products or scraps, and the use and storage of nitro-cellulose film.

The term pyroxylin plastics was held to mean and include any plastic substance, material or compound having soluble cotton or similar nitro-cellulose as a base, and thus includes celluloid, fiberloid, pyralin, viscoloid and similar products, whether in the form of blocks, slabs, sheets, tubes or fabricated shapes, as well as lacquers, enamels, paints, thinners, cement and dope. Copy of the full report can be secured from the secretary-treasurer, F. H. Wentworth, 87 Milk St., Boston, Mass. The committee on gases also presented a tentative report for the regulation of refrigerating machines and refrigerants, and tentative regulations for the installation and operation of acetylene compressive plants.

New Amendment to Dye Bill Would Provide an Automatic Tariff

Senator Moses has offered an amendment to the dye bill which eliminates the embargo system and provides for an automatic tariff which is to be the difference between the price of a foreign article and the price of a similar article made domestically plus 20 per cent. He cites examples as follows: If foreign dye cost $2 per lb. to import and the fair selling price of a similar dye made domestically is $4, the tariff would be $2 plus 20 per cent of the home market value, or 80c., bringing the price of the imported article up to $4.80. If the price of the imported article were 15c. per lb. and the price of the home article $4, the tariff would be $3.85 plus 20 per cent. Senator Moses says that his proposal "is automatic and elastic and adjusts itself to every price and at all times places the price of a foreign dye 20 per cent above the price of a similar domestic dye."

The bill also provides that no person can bring in more than enough dyes at one time to suffice him for the current year. It contains a provision for ascertaining prices within the United States, the same as prices now are ascertained in foreign countries. This, Senator Moses thinks, would give absolute protection to the dye industry without embarrassing the textile industries with licenses, permits and embargoes.

Chemists' Club Elects Officers

At the annual meeting of the Chemists' Club held May 5, the following officers were re-elected:

President, Ellwood Hendrick; vice-president, resident, William F. Hoffmann; vice-president, non-resident, V. G. Bloede; secretary, J. R. M. Klotz; treasurer, Henry M. Toch; F. J. Metzger and T. R. Duggan, trustees.

Edgar F. Smith of Philadelphia, William H. Nichols of New York, John Uri Lloyd of Cincinnati, Edward Weston of Newark, H. le Chatelier of France, Ernest Solvay of Belgium, Giacimo Cimician of Italy and T. E. Thorpe of England were elected honorary members.

Lignite Carbonization Research Plant

After some months of investigation and negotiation, the United States Bureau of Mines has completed arrangements for a co-operative plan to carbonize lignite and develop the necessary information that it is hoped will "make possible a favorable technical and business report which shall stimulate duplication of such plants throughout lignite areas."

To this end a co-operative agreement has been made between the Bureau of Mines and John B. Adams and Fred Bremier, under which an appropriation of $100,000 and an additional $200,000 which is to be furnished by these individuals will be used for the construction of the plant required, and as a working capital for its operation. The plant will be installed at New Salem, N. D., on the site owned by the Consolidated Lignite Collieries Co., a subsidiary of which is to be organized by the two men who are contracting with the Government.

The plant contemplated will consist of a battery of ovens of new form which have been designed by the engineers of the Bureau of Mines, under the direction of O. P. Hood, chief mechanical engineer. This battery will, it is estimated, coke at least 100 tons of raw lignite per day and provide for complete recovery of the liquid and gaseous byproducts as well as for the handling of the char, from which it is planned to produce briquets. The briquetting plant will also be of special design, and it is to be an integral part of the plant, so that the char will be handled direct from the battery to the briquetting machine hoppers.

The substance of the agreement under which this work will be done is as follows:

Substance of the Agreement

It is proposed that the Bureau of Mines plan, erect and operate for a period a plant to carbonize brown lignite, briquet the solid residue, utilize the gas, recover tar and oils, measure and investigate all quantities, report on the process, including costs, selling prices and profits.

The plant would require three types of equipment:

1. Standard parts such as rail connections, coal-handling machinery, bins, driers, screens, briquetting equipment, etc., all of which can be purchased on the market from more than one source.

2. Special equipment more or less new in principle and development, part of which has resulted from the work of S. M. Darling.

3. Measuring, sampling and testing devices not usually necessary in a standardized commercial undertaking, but necessary in directing a new process and investigating performance.

It is proposed that the Bureau supply complete plans for the plant, have oversight over the construction and operation, and furnish items classified under 2 and 3.

It is proposed that the co-operating company approve the plans of construction, furnish items under classification 1, furnish all lignite and other raw materials, supplies and operating labor, market all products and conduct the business, leaving the Bureau funds for general oversight, investigation, control of the technical processes and the preparation of a report.

When the investigation fund is exhausted and the fixed structures sold, the co-operative company shall bid an amount equal to the replacement value, less reasonable depreciation.

American Zinc Institute Meeting

The second annual meeting of the American Zinc Institute was held at the Congress Hotel, Chicago, May 10 and 11. A large percentage of the 200 members attended, the tri-state, or Joplin district, being particularly well represented.

During the technical sessions George C. Stone delivered a paper on the differences in European and American zinc smelting practices. He noted that the American industry consumes ore from its own mines, while 80 per cent of that smelted in Europe is imported from Australia and north Africa. It is shipped in cargo with wool at a price which in normal times compares with freight rates on ores in the United States.

This importation permits a wide variety of selection of ores and the producer therefore designs his smelting plant with a certain shaped retort, to work at certain temperatures, with a specific grade of ore in view, and then purchases the ore to fit the furnace. In the American practice one general type of furnace is employed and used for the refining of any type of ore. This does not make for such economies as are enjoyed by the European concerns.

In Europe the fuel economy is very high due to the use of regenerative furnaces of both the recuperative and reversing type. From eight-tenths to one ton of coal is consumed per ton of ore in the European furnaces, while in America, where very few regenerative furnaces are in operation, from two to four tons of fuel per ton of ore is consumed.

The European concerns also exercise more care in the manufacture of their refractory materials in the retort, this being a direct result of the higher development of the ceramic industry among metallurgical producers.

The finished products of the European furnaces analyze much more consistently in impurities than is the case in the irregular American practice. The overall recovery in Europe is 84 per cent of the zinc contained in the ore, while in the United States it averages below 81 per cent. Should American firms adopt European practice, about 20,000 tons of ore would be saved per annum and several hundred thousand tons of coal. On the other hand, the American companies have more mechanical labor-saving devices than are used in Europe.

The discussion on this paper brought out the fact that most zinc producers are not familiar with the practice of mixing ores to get the maximum recovery of metal and the minimum slagging of retorts. Albert M. Plumb urged the further study of American ore mixtures from the point of view of iron, lime and silica content as it affects retort consumption. There are few ores in the United States that are not basic, and the recovery may be increased by more careful regulation of furnace temperatures.

Annual Meeting of the Chicago Chemists' Club

The first annual meeting of the Chicago Chemists' Club was held May 7, and the following officers were elected: President, William Hoskins; first vice-president, F. N. DeBeers; second vice-president, W. Lee Lewis; secretary, Paul VanCleef; treasurer, C. C. Kawin; trustees to serve for three years, Herbert N. McCoy and W. R. Smith.

Reports showed that the club now has a membership of eighty-nine, three of whom are non-residents.

Stamford Chemical Society Meeting

The eighth monthly meeting of the Stamford Chemical Society was held on Monday evening, April 26, at the Stamford High School Building. The two points of interest at the meeting were the election of officers and the rendering of a paper on "Allotropism Among the Metals," by Dr. F. H. Getman, president of the society. The paper was based largely upon the author's research work.

Allotropism Among the Metals

The phenomenon of allotropism was defined by Dr. Getman as the existence of an element in several physical forms; the chemical properties remaining the same. This phenomenon was first forcibly brought to the attention of the scientific world when a large shipment of tin, which was stored for a considerable time in Russia, was found in the form of a gray powder. Fraud was at once suspected. Chemical analysis, however, proved the material to be a high grade of tin.

As a result of recent investigations it has been shown that cadmium, zinc, lead, copper, tin, bismuth, antimony and sodium are in reality metastable systems consisting of two or more allotropic forms. The apparent stability of these metals is to be ascribed to marked retardation accompanying the reversible change of the different allotropic modifications in the neighborhood of their transition points. It is possible to accelerate these reversible transitions and to determine with considerable accuracy the transition temperatures and thus ascertain the conditions of stability of the metals. Obviously the physical and mechanical constants which have hitherto been determined refer to more or less complicated metastable systems.

The members of the society were very much interested to learn that Dr. Cohen, of the University of Utrecht, Netherlands, and Dr. Getman were both working, at the same time, on the allotropic forms of cadmium and that they both arrived at identical generalizations, although they worked from entirely different angles. While Dr. Cohen determined the density and some of the other physical properties of the different allotropic forms of cadmium for comparison, Dr. Getman determined with great accuracy the electrical potential between the different allotropic forms under various conditions.

U.S.P. Revision Organized

Manufacturers of drugs, pharmaceuticals and other chemicals listed in the U. S. Pharmacopœia should get in touch with the Committee on Revision which has just been organized and authorized to proceed on the preparation of the tenth edition of this volume. The U. S. Pharmacopœial Convention was held in Washington on May 11 and 12 for a discussion of the principles to be followed in this revision. Rules were adopted with respect to the object and scope of the work, doses, nomenclature, synonyms, purity and strength of pharmacopœial articles, international standards, physical constants and other related subjects. Some of the points of interest to chemical manufacturers are included in the following provisions:

In the case of newly admitted articles, it is recommended that such titles be chosen as are in harmony with general usage and convenient for prescribing; for synthetic chemicals, with lengthy or unwieldy names, the Committee of Revision shall be empowered to coin short euphonious titles, contracted, if possible, from the true chemical names, but in the case of chemicals of a definite composition the scientific name shall be given, at least as a synonym.

It is recommended that the standard temperature of 25 deg. C. (77 deg. F.) be retained in the revision (except in the case of alcohol) and that an alcoholometric table be inserted in Part II giving the percentage of alcohol at different temperatures.

It is recommended that the Committee of Revision be instructed to revise carefully the limits of purity and strength of the Pharmacopœial chemicals and preparations, for which limiting tests are or may be given. While no concession should be made toward diminution of medicinal value, an allowance should be made for unavoidable, innocuous impurities or variations due to the particular source or mode of preparation, or to the keeping qualities of the several articles.

The "Purity Rubric," which limits the percentage of innocuous impurities, as introduced in the previous revision, should be continued, and tests and requirements should be appended to each article for which a "Purity Rubric" is given.

It is recommended that a range of the content of absolute alcohol, by volume, be stated in the Pharmacopœia, accompanying the text, for each preparation containing alcohol.

It is recommended that official methods for taking physical constants shall be stated in the Pharmacopœia, and these shall apply to all articles in which physical constants are officially used, unless otherwise specifically excepted.

The Committee of Revision will have as its chairman Fullerton E. Cook, and Charles H. LaWall as its secretary. Prof. LaWall's address is 39 South 10th St., Philadelphia, Pa.

It is expected that the Committee of Revision will make public, for comment and criticism, an abstract of new descriptions and standards, and all important changes in preparations and standards proposed, before final adoption.

Washington Chemical Society Meeting

Dr. A. M. Comey addressed the Chemical Society of Washington on the subject of high explosives on May 13. He discussed the development of these materials from straight dynamite through gelatine dynamites, Judson powders, ammonia dynamites, ammonia-gelatine dynamites, permissible explosives and low-freezing dynamites. Mercury fulminate and its principal substitute lead azide (PbN_6) were also described. Methods of testing for strength, speed of detonation and sensitiveness of these and the various military high explosives, of which TNT is the preferred form, were described in detail.

One of the most striking developments in high-explosive work pointed out by Dr. Comey was the partial elimination of nitroglycerine from dynamites; about 40 per cent was an average figure fifteen or twenty years ago, whereas 20 per cent represents present practice.

The next meeting of the society will be held at the Geophysical Laboratory on May 27, at which time Dr. Arthur L. Day will address the membership. Dr. Day has recently resumed his active direction of the work of this laboratory. The various laboratories of the institution will be open for inspection on the evening of the meeting.

First Step Toward Department of Public Works

Passage by the Senate of a bill providing for a joint Committee on Reorganization of the Government Departments and the probability that similar action will be taken promptly by the House is regarded as a long step forward in the campaign to secure a Department of Public Works and other changes in the organization of administrative agencies in Washington. The bill provides for a study of the situation by three members of the Senate and three members of the House. The final report of the committee must be submitted at the opening of Congress in December, 1922. After speeches in favor of the resolution had been made by Senator Smoot, in immediate charge of legislation for the majority, and Senator Underwood, the Democratic leader, the Senate passed the measure by acclamation.

Annual Alumni Banquet of the Chemical Society of Brooklyn Tech

The annual dinner of the Chemical Society of Brooklyn Tech was held at the Chamber of Commerce Club on Saturday evening, May 15. About one hundred students and alumni were present.

Dr. B. Palmer Caldwell was called upon as the most recent addition to the faculty and spoke of the great difference between teaching in the country and in this metropolitan center. He took occasion to show that Dr. Pritchard's criticism of the research work carried out in American colleges and universities was entirely unjustified and that it was vital that much more liberal appropriations be made for this important work. Dr. William H. Nichols later emphasized the same point and showed that much harm would result from the curtailment of university research work.

Dr. Nichols, who is chairman of the board of trustees of the Polytechnic Institute, told the young men present of the tremendous development which had taken place in the chemical industry since he studied chemistry at the Brooklyn Tech. He gave it as his opinion that the developments in the chemical field in the immediate future would far surpass the achievements of the past. He also related some personal incidents in connection with the development of the American dye industry, particularly in the manufacture of aniline oil before the war, which proved to be of the greatest importance when it became necessary to manufacture smokeless powder for which diphenylamine is so essential.

The last speaker of the evening was Dr. Charles H. Herty, who spoke of the failure of the War Department to recognize the value of chemists at the beginning of the late war. He stated that the lack of appreciation of the chemist by the public in general was due largely to the unwillingness of the chemists themselves to inform the newspaper reporters on chemical matters. In speaking of the dye industry, Dr. Herty said that while it was only a small industry in itself it influenced a great many larger industries such as the textile and leather industries. He believed that the dye industry must be protected against foreign competition and vigorously attacked Senator Thomas for opposing the bill in Congress for that purpose. In concluding, Dr. Herty said that the dye industry is not only the main reserve in chemical warfare, but that the health of the people of America depends upon it.

The dinner was a most enthusiastic and delightful occasion. College songs and cheers added pep to the affair.

Book Reviews

CAST IRON IN THE LIGHT OF RECENT RESEARCH. By *William Herbert Hatfield, D.Met.* (Brown-Firth Research Laboratories, Sheffield). London: Charles Griffin & Co., Ltd., 1918. Second edition.

The first edition of this work, which appeared in 1912, attracted the attention in this country of metallurgists and others, not only on account of the original matter of interest and importance contained therein but also from the fact that it was, perhaps, the first fairly complete compilation in one volume of numerous researches and discoveries of very many workers during the last half century. Beginning practically with the classic writings of Prof. Thomas Turner on the influence of silicon in cast iron, published in 1885—an investigation which has had a profound effect upon modern methods in foundry practice and also even in the making of pig iron for foundry use—down to 1912, this book was a compendium of nearly all the important papers that were scattered throughout the journals of technical societies and periodicals up to that year.

The second edition has wisely adhered closely to the original scheme and has added four new chapters, increasing the number of pages from 244 to 286, not counting the indexes. Some idea of the thoroughness of this compendium may be gained from the fact that the index of names in the new edition contains no less than 140 names, from which, by the way, the author has modestly omitted his own name, though the book contains some of his original investigations, such as on page 89, *et seq.*, on the "Influence of Vanadium in Cast Iron."

The reviewer must remember that the work should be judged from the standpoint of metallurgical practices in Great Britain, which differ in some respects from our American practice. *E.g.*, the chilled cast-iron car wheel is peculiarly an American industry of vast proportions; there are probably today over 20,000,000 chilled cast-iron car wheels running on American railroads in freight service under cars with capacity up to 100,000 lb. and over, and the end is not yet reached!

Chapter V, on "The Influence of Manganese," shows its well-known action in neutralizing sulphur; its effect on the iron-carbon system; its influence on white cast iron and on gray cast iron; but no mention is made of the truly remarkable effect of adding a minute quantity of powdered 80 per cent ferromanganese in a ladle of molten high chilling car-wheel iron, increasing the strength over 30 per cent and decreasing the shrinkage in like proportion. It acts here as a desulphurizing and de-oxidizing flux. Since this process was published in 1888 (see *Journal of the Franklin Institute* for March, 1888), the method has been generally used with very great benefit in the manufacture of chilled cast-iron car wheels and other chilled castings. Chapter II devotes twenty pages to "The Influence of Silicon," and an elaborate discussion of the manner in which this element operates on cast iron, but no mention is made of the use of permanent iron molds in making machinable castings of exceedingly fine grain, free from blow holes, graphite and sand pits, etc. Since 1888 one foundry in Philadelphia has made an enormous number of machinable gray-iron castings in permanent iron molds, some of the original molds being still in use; this foundry has more than one hundred permanent iron molds. When it is realized that surface "chill" on a casting made in an iron mold (which may be not thicker than a sheet of tissue paper) will make the casting too hard to be readily machined, the fact that suitable treatment of the metal with silicon has made machinable castings in iron molds a *fait accompli* for thirty years, the value of that element may be more fully appreciated.

In conclusion, the reviewer would say that this book is one of great value to the metallurgist, the engineer and the educated foundryman.

ALEXANDER E. OUTERBRIDGE, JR.

Personal

CARL G. BARTH, a pioneer in the machinery-building industry, has been elected an honorary member of the Taylor Society. Only two other men have been thus honored by the Society, which is the national organization for the promotion of science in management, these being Frederick W. Taylor and Henri Le Chatelier, the engineer who developed scientific management in France.

J. E. BARTLETT has been elected president and general manager of Parke, Davis & Co., Detroit, Mich., succeeding the late Frank G. Ryan.

H. C. BELLINDER, general manager of the Chile Copper Co., arrived in New York from Chile on May 7.

Dr. WILLIAM BLUM, chemist in the National Bureau of Standards, spoke before the electroplaters of Providence, R. I., on May 11, describing the work which the Bureau is doing in this field, particularly the opportunities for research as a means for improving commercial electroplating practice.

Colonel MARSTON TAYLOR BOGERT, of the Department of Chemistry, Columbia University, has been elected president of the American Section of the Société de Chimie Industrielle of France. Prof. Bogert was president of the Society of Chemical Industry of England in 1913, and has been twice president of the American Chemical Society.

J. A. BRETZ has resigned as chief chemist and metallurgist of the Bettendorf Co. to take charge of the laboratory of the Southern Manganese Corp., Anniston, Ala.

C. E. BRODERS has resigned from the staff of the C. F. Burgess Labs. to take a position with the U. S. Auto Gear Shift Co., Eau Claire, Wis.

DONALD G. CLARK, district manager of the Firth Sterling Steel Co., spoke before the American Steel Treaters Society, May 19, on "The Heat Treatment of Stainless Steel."

Dr. COLIN G. FINK of New York lectured to the graduate students of Yale University on "The Organic Chemistry of Metal Carbides" and "Contact Catalysis."

L. W. JONES, dean of the college of engineering and architecture and dean of the school of chemistry, University of Minnesota, has resigned to become professor of organic chemistry, Princeton University, Princeton, N. J.

ROBERT M. KEENEY, electrometallurgist, Denver, Col., attended the convention of the National Electric Light Association at Pasadena, Cal., and read a paper on electric furnace practice.

C. H. KIDWELL, of the staff of the United States Geological Survey, has resigned to join the chemical staff of the Solvay Co., at Syracuse, N. Y.

DORSEY A. LYON is making a tour of the Western stations of the Bureau of Mines.

C. H. WOLFF was elected president of the American Zinc Institute at the annual meeting recently held in Chicago.

CLARENCE A. WRIGHT, hydrometallurgist for the Bureau of Mines at the Salt Lake station, has resigned, the resignation to take effect June 1. He expects to sail for Italy the latter part of June to engage in metallurgical work.

Obituary

HARLEY T. PROCTER, who for many years carried on the business of Procter & Gamble, manufacturer of Ivory Soap, died recently of diabetes at his home in New York City, in his seventy-third year. He had retired twenty-five years ago from active connection with the affairs of the company, which was founded by his father, William Procter. Mr. Procter was a member of the Metropolitan and Manhattan clubs.

Current Market Reports

The Non-Ferrous Metal Market

New York, May 24, 1920.—Price for copper is unchanged at 19¼c., which is regarded as being a rock-bottom quotation. Tin continued to decline, 52¼c. being the present figure. Other markets are steady.

	Cents per Lb.
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent	32@33
Antimony, wholesale lots	9.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	52.25
Lead, New York, spot	8.80
Lead, E. St. Louis, spot	8.50
Zinc, spot, New York	8.55
Zinc, spot, E. St. Louis	7.60

OTHER METALS		
Silver	oz.	$0.99¾
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.70@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.60@1.85
Platinum	oz.	110@115
Iridium	oz.	300.00
Palladium	oz.	105@115
Mercury	75 lb.	92.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper bottoms	38.50
Copper rods	27.50
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless high brass tubing	30.50

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	21.75@22.75
Aluminum, sheet scrap	21.25@22.50
Copper, heavy machinery comp	13.50@14.00
Copper, heavy and wire	13.50@13.75
Copper, light and bottoms	12.25@12.75
Copper, heavy cut and crucible	14.75@15.00
Brass, heavy	7.50@ 8.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	8.25@ 8.50
No. 1 comp. turnings	10.25@10.75
Lead, tea	5.25@ 5.40
Lead, heavy	7.00@ 7.25
Zinc, scrap	4.25@ 4.50

The Iron and Steel Market

Pittsburgh, Pa., May 21, 1920.

While the number of rail strikers may have decreased somewhat in the past week or two, the traffic situation is distinctly worse, on account of congestion, and production of pig iron and steel has decreased rather than increased, being now hardly greater than it was when the strike effect was felt most seriously, toward the latter part of April.

The curtailment in operation is progressive, from the blast furnace through to the finishing departments. There is slightly less coke than there was a fortnight ago, due to increased car shortage at beehive coke ovens and at coal mines supplying byproduct ovens, hence there is less pig iron being produced. There is still less production of steel, with accumulation of pig iron at some works, either through stocks of steel having become uncomfortable or through there being a shortage of gas coal for open-hearth furnaces. Of the steel produced not all is going through the blooming mill, there being accumulation of ingots at some plants, while as to finishing departments some of the steel is being put into billets and sheet bars, as materials that can be most easily stocked. Finally, of the finished steel that is made a considerable percentage is not shipped, as the car supply is insufficient even for the reduced production.

The car supply is so poor now that there is no longer much question, from the steel mill viewpoint, of lines of communication being open to customers.

A rough guess as to the amount of steel now accumulated may be of interest. Only a guess can be made, but even that is suggestive. One starts with the ingot production

in March, when the rate was the heaviest since October, 1918. The American Iron and Steel Institute report, covering the output in that month of thirty companies which, in 1918, made 84.03 per cent of the country's total, indicated a rate in March of about 45,200,000 gross tons per annum. The normal ratio is 76 per cent for finished rolled steel, as reported in the statistics, to ingots. Applying 76 per cent, dividing by 52 and passing from the gross to the net ton, one finds a weekly rate of finished rolled steel production of 750,000 net tons, or 125,000 tons per working day. Thus far the computation is reasonably exact and accurate. Another fairly well-known fact is that the rail strike has an average life of about seven weeks to date, having begun in the Chicago district April 1, reaching the valleys and Pittsburgh about Monday, April 12. Assuming production to have averaged 80 per cent of the March rate and shipments 65 per cent of the production, the shipments were 52 per cent of the March rate, leaving 28 per cent at the mills, 28 per cent of 750,000 tons a week for seven weeks being 1,470,000 net tons. There was an accumulation of steel at mills on April 1, apparently large at the time, due to the car shortage earlier in the year, so that a fair guess would be more than 1,500,000 net tons of steel now at mills in equivalent of finished steel, but a part of it really in ingot, billet and sheet bar form awaiting finishing at a more convenient time when fuel is less scarce. On account of mill limitations that part of the stock will be some time getting worked off, while the finished product will also move slowly, at best, for the ending of the rail strike itself, whenever that occurs, will be followed by car shortage and only gradual relief from present congestion.

Markets Apathetic

Buyers of pig-iron and steel products are showing no interest whatever. They could, perhaps, be taking their cue from the stocks of material that have been accumulating, but undoubtedly they are greatly influenced by the very apparent unsettlement of business and financial conditions generally. Buyers of steel always keep an eye on the stock market and there has never been a free movement in steel buying when Wall Street was showing serious declines.

For several weeks the important but unanswered question has been how the consumption of steel was comparing with the production. There are cases of factories closing from lack of steel and other cases of factories running very well, and no comprehensive survey has been made. As noted in this report a week ago, if consumers have been maintaining operations to any extent by drawing upon stocks, and thus consuming more steel than is received, the stocks must have been accumulated at some time, and the only time was last February and March. However, one day last week, when the rail strike was about six weeks old, Ford made a new record for a day's output with 4,600 cars.

Prices

There is no declining tendency apparent in prices, except in prices for prompt steel, and that might be due to there being less bidding because prompt shipment might not mean anything like prompt delivery. In a quiet market, of course, the mills having the least business on books and therefore having the highest prices would naturally approach the end of their orders sooner than others, and would thus be moved to reduce prices. Mills that are booked for a few months have no incentive to reduce prices, it being axiomatic in the steel trade that, generally speaking, reducing prices does not stimulate buying. The exception is when buyers and sellers have played the "waiting game" for a long time. There are now predictions in some quarters that there will be no very active market in steel generally until prices have all declined to the Steel Corporation or Industrial Board level. No one predicts that that schedule of prices is in danger.

Pig-iron transactions are confined to small lots for early shipment, such business making the only market quotable, and thus the market is unchanged, though forward deliveries are not tested. Quotations are: Bessemer, $42.50; basic, $43; foundry, $44@$45, f.o.b. valley furnaces, freight to Pittsburgh being $1.40.

Ferro-Alloys

A few consumers of ferromanganese have run decidedly short, due in part to delay in receipt of ferromanganese purchased long ago in England, and the prompt market is still, with $250, delivered, readily obtainable, and perhaps up to $260, but the shipment must really be prompt, as the middle of the year is only six weeks distant and second half deliveries are merely firm at $200, delivered. Spiegeleisen is $72.50@$75, furnace, for spot, being both firm and quiet at that level. Electrolytic ferrosilicon is quiet at $78@$80, delivered, with 75 per cent not tested, but probably about $155. Bessemer ferrosilicon remains at $62.50 for 10 per cent, $65.80 for 11 per cent and $69.10 for 12 per cent, f.o.b. furnaces at Jackson and New Straitsville, Ohio.

The Chemical and Allied Industrial Markets

New York, May 21, 1920.

There has been little if any activity in the local market since the last report. While producers, in most instances, report a satisfactory supply of crude material, they are met with the difficult task of finding means to transport it from the sources or from intermediate points of shipment.

With plenty of alcohol at the distilleries, the obstacles confronting the shipper have brought a rise in the denatured product slightly above the dollar mark per gallon in less than carload lots, f.o.b. New York, and there are prospects of a further increase. Importation of *barium chloride*, in limited quantities, had been able to ease the demand, but frequent withdrawals by the German Government of permission to export have produced a growing scarcity. Current quotations in less than carload lots range from $175 to $200 per ton. *Glycerine*, with a steady demand, has shown an increase from the previous quotation of 24½@28½c. per lb. to 26½@28½c., and unless new sources and lower prices of crude oil are obtained there is little likelihood now of a return to the old prices. The same conditions affect *paraffine waxes*, where an increase in price has been the result. One of the leading manufacturers quotes crude match wax (white), 105-110 m.p., at 10c. per lb., a movement from 9½c., with like increases in other grades. *Zinc chloride, granular*, ranges up from 13½c. per lb. in less than carlots, one dealer securing spot goods at 15c. per lb. notwithstanding the scarcity of the product. There appears to be a sufficient supply of *sodium carbonate* in the vicinity, but conditions are such as practically to isolate it. *Sodium cyanide*, 96-98 per cent, continues to be quoted at 24@25c. per lb. despite a temporary shortage due to the accidental loss of one large shipment. Continued lack of raw material has caused a rise in price of *acetic acid*, 56 per cent, to $7.50@$8 per cwt. in carlots. There has been little movement in this or other acids, and with the exception of acetic, no revision of quotations.

Vegetable Oils

A marked decrease in the prices of domestic *linseed oil* has followed the lower quotations of the English product. Raw material in carlots is quoted today at $1.65 per gal. while the raw imported from England ranges in price from $1.45 to $1.50 in barrels. Domestic linseed oil, raw, in tank cars, shows a drop to $1.60 and a similar reduction is noted in carlot quotations of the boiled material. Higher cost of manufacture here will probably prevent the equalization of domestic and imported oils. At the same time, importation in quantities will continue so long as it aids substantially, as it has been doing, in restoring the English sovereign to its pre-war value. *Olive oil*, commercial, is now quoted at $3.10@$3.25, a sudden increase and due solely to the embargo placed by Spain.

Naval Stores

In anticipation of the arrival of the new product, prices of *rosin* have declined, but thus far it has been an almost impossible matter to secure shipments from the South. The B-D type in barrels of 280 lb. is quoted at $15.95@$18.75, *rosin oil* of the first run declining to 85c. per gal., second run, 88c., third run and fourth run, $1.05. *Turpentine* remains firm with little movement by shippers.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.65 – $0.75
Acetone	lb.	$0.19 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.25
Acetic, 56 per cent	cwt.	7.50 – 8.00	8.75 – 9.00
Acetic, glacial, 99½ per cent. carboy	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Citric	lb.	.85 – .86	1.17 – 1.18
Hydrochloric (nominal)	cwt.	3.00 – 3.25	3.50 – 4.00
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.13½ – .14
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric).			
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09¼
Oxalic, crystals	lb.	.55 – .57	.58 – .59
Phosphoric, Ortho, 50 per cent solution	lb.	.22 – .23	.24 – .25
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 18.00	—
Sulphuric, 60 deg., drums	ton	—	—
Sulphuric, 66 deg., tank cars	ton	21.00 – 25.00	—
Sulphuric, 66 deg., drums	ton	35.00 – 40.00	50.00 – 55.00
Sulphuric, 66 deg., carboys	ton	36.00 – 40.00	50.00 – 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P.	lb.	1.50 – 1.60	1.65 – 1.70
Tannic (tech.)	lb.	—	.60 – .90
Tartaric, crystals	lb.	—	.80 – .85
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.50 – 3.50	—
Alcohol, denatured, 188 proof (nominal)	gal.	—	1.05 – 1.10
Alcohol, denatured, 190 proof (nominal)	gal.	—	1.00 – 1.05
Alum, ammonia lump	lb.	.04½ – .05	.05½ – .06
Alum, potash lump	lb.	.07½ – .08½	.09 – .09½
Alum, chrome lump	lb.	.15½ – .18	.19 – .20
Aluminum sulphate, commercial (nominal)	lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03¼ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ – .13½	.13½ – .14¼
Ammonium nitrate	lb.	.08¼ – .12	—
Ammonium sulphate	lb.	.07 – .07½	.08½ –
Amylacetate	gal.	—	—
Amylacetate tech	gal.	—	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	—	.13½ – .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	—
Barium chloride	ton	150.00–160.00	1.75 – 2.00
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.85 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	—
Calcium carbide	lb.	.04½ – .04¾	.04¾ – .05½
Calcium chloride, fused, lump	ton	23.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.50 – 5.00
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Ethyl Acetate Com. 85%	gal.	1.35 –	1.40 –
Ethyl Acetate pure (acetate ether 98% to 100%)		—	1.75 –
Formaldehyde, 40 per cent (nominal)	lb	.38 – .40	.57 – .65
Fusel oil, ref.	gal.	—	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	—	—
Glauber's salt (see sodium sulphate)		—	—
Glycerine	lb.	—	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	—	.13½ – .15½
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	—	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 –
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.50 – 3.55	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	—	3.25 – 3.60
Nickel salt, double	lb.	—	.14 – .16
Nickel salt, single	lb.	—	.16 – .18
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.36 – .37	.45 – .46
Potassium bitartrate (cream of Tartar)	lb.	.53 – .56	.57 – .58
Potassium bromide, granular	lb.	.80 – .85	.90 – .95
Potassium carbonate, U. S. P.	lb.	—	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.14 – .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.31 – $ .32
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.15 – .17	.19 – .21
Potassium permanganate	lb.	—	.85 – .95
Potassium prussiate, red	lb.	$0.90 – $1.00	$1.05 –
Potassium prussiate, yellow	lb.	.32 – .36	.36½ – 0.37½
Potassium sulphate (powdered)	ton	$225.00 – 240.00	—
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake	ton	28.00 – 32.00	—
Silver cyanide (nominal)	oz.	—	1.25 –
Silver nitrate (nominal)	oz.	—	.74 – .76
Soda ash, light	100 lb.	—	3.50 – 3.60
Soda ash, dense	100 lb.	—	3.55 – 3.65
Sodium acetate	lb.	.08½ – .09	.09½ – .12
Sodium bicarbonate	100 lb.	2.25 – 2.60	2.75 – 3.50
Sodium bichromate	lb.	.33 – .35	.36 – .37
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .10½
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	—	.10 – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	5.00 – 6.00	6.25 – 6.50
Sodium hyposulphite	lb.	—	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25½ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.20 – .21	.24 – .25
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	—	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .02	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02¼
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.25
Sodium sulphide, crystal, 60–62 per cent (cone)	lb.	.09 – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.23 – .24	.25 – .26
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	—
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	42½ –	.46 – .50
Tin oxide	lb.	.60 – .63	.65 –
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 –	.13½ – .17
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.12½ –	.13 – .15
Zinc oxide, U. S. P.	lb.	.18 – .19	.20 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	—	$1.25
Alpha naphthol, refined	lb.	—	1.45
Alpha naphthylamine	lb.	.65 —	.70
Aniline oil, drums extra	lb.	.35 —	.40
Aniline salts	lb.	.45 —	.50
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.35 —	1.40
Benzidine, sulphate	lb.	1.20 —	1.25
Benzoic acid, U.S.P.	lb.	.90 —	1.10
Benzoate of soda, U.S.P.	lb.	.80 —	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.36
Benzol, 90% in drums (100 lb.)	gal.	.25 —	.31
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate (nominal)	lb.	.50 —	.65
Beta naphthol, sublimed (nominal)	lb.	—	1.00
Beta naphthol, tech (nominal)	lb.	.75 —	.85
Beta naphthylamine, sublimed	lb.	2.25 —	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 —	1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 —	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 —	.75
Dichlorbenzol	lb.	.08 —	.10
Diethylaniline	lb.	—	1.80
Dimethylaniline (nominal)	lb.	1.50 —	1.55
Dinitrobenzol	lb.	.30 —	.37
Dinitroclorbenzol	lb.	.30 —	.35
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.40 —	.45
Dinitrotoluol	lb.	.40 —	.45
Dip oil, 25% tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine (nominal)	lb.	—	.85
H-acid (nominal)	lb.	2.25 —	2.50
Metaphenylenediamine	lb.	1.15 —	1.80
Monochlorbenzol	lb.	.12 —	.15
Monoethylaniline	lb.	1.70 —	1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.15 —	—
Naphthaline, flake	lb.	.15 —	.17
Naphthaline, balls	lb.	.16 —	.18
Naphthionic acid, crude	lb.	.75 —	.85
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.50
Nitro-toluol	lb.	.20 —	.30
Ortho-amidophenol	lb.	3.25 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.80 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.35 —	.45
Para-amidophenol, base	lb.	2.50 —	3.50
Para-amidophenol, HCl	lb.	2.50 —	3.25
Para-dichlor-benzol	lb.	.08 —	.12
Paranitraniline	lb.	—	1.65
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.60 —	3.00
Paratoluidine	lb.	2.00 —	2.50
Phthalic anhydride	lb.	.65 —	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 —	.25
Pyridin	gal.	2.00 —	2.50
Resorcin, technical	lb.	4.25 —	4.50
Resorcin, pure	lb.	6.25 —	6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0.50	—	$0.52
Salicylic acid, U. S. P.	lb.	.55	—	.60
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	—	.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.28	—	.32
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.39	—	.40
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	.93	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.88
Carnauba, No. 3, North Country (nominal)	lb.	.44	—	.45
Japan	lb.	.21	—	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09½	—	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.....	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	—	.12
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	—	.14
Paraffine waxes, refined, 133-135 m.p.	lb.	.15½	—	.16½
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	—	.18½
Stearic acid, single pressed	lb.	.25	—	.26
Stearic acid, double pressed	lb.	.26	—	.27
Stearic acid, triple pressed	lb.	.28	—	.29

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.75
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.090	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	115.95	—	$18.75
Rosin E-I	280 lb.	18.75	—	19.00
Rosin K-N	280 lb.	19.00	—	21.00
Rosin W. G.-W. W.	280 lb.	20.50	—	21.50
Wood rosin, bbl.	280 lb.	17.50	—	18.50
Spirits of turpentine	gal.	.....	—	2.45
Wood turpentine, steam dist.	gal.	2.35	—	2.40
Wood turpentine, dest. dist.	gal.	.....	—	2.00
Pine tar pitch, bbl.	200 lb.	8.40	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.85	—	.95
Rosin oil, second run	gal.	.88	—	.97
Rosin oil, third run	gal.	1.00	—	1.05
Rosin oil, fourth run	gal.	1.05	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.39½	—	$0.40
Upriver coarse	lb.	.29	—	.29½
Upriver caucho ball	lb.	.30½	—	.....
Plantation—First latex crepe	lb.	.....	—	.38
Ribbed smoked sheets	lb.	.37½	—	.38
Brown crepe, thin, clean	lb.	.....	—	.35
Amber crepe No. 1	lb.	.....	—	.40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.22
China wood oil, in bbls.	lb.	.22½	—	.23½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½	—	.18¾
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.19½	—	.20½
Corn oil, crude, in bbls	lb.	.17½	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15¾	—	.16
Cottonseed oil, summer yellow	lb.	.19	—	.19½
Cottonseed oil, winter yellow	lb.	.21	—	.22
Linseed oil, raw, car lots (domestic)	gal.	1.65	—	.....
Linseed oil, raw, tank cars (domestic)	gal.	1.60	—	.....
Linseed oil, boiled, car lots (domestic)	gal.	1.67	—	.....
Olive oil, commercial	gal.	3.10	—	3.25
Palm, Lagos	lb.	.13½	—	.14
Palm, bright red	lb.	.13	—	.13½
Palm, Niger	lb.	.12	—	.13
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.16½	—	.17½
Peanut oil, refined, in bbls.	lb.	.22	—	.24
Rapeseed oil, refined in bbls.	gal.	1.70	—	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80	—	1.82
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.13	—	.13½

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.30	—	1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$20.00	—	$22.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	16.00	—	18.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	—	10.00
Blanc fixe, dry	lb.	.05½	—	.06½
Blanc fixe, pulp	ton	60.00	—	80.00
Casein	lb.	.15	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin) crude, f.o.b. Pkin, Va.	net ton	8.00	—	12.00
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50	—	18.00
Feldspar, crude, f.o.b. Maryland and North Carolina, points	net ton	7.50	—	8.00
Feldspar, ground, f.o.b. Baltimore	net ton	18.00	—	25.00
Fire clay, f.o.b. Baltimore	net ton	5.00	—	7.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	.....	—	0.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	.....	—	0.01½
Graphite, crucible, 85% carbon Ashland, Ala.	lb.	.....	—	.07
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	.....	—	.08½
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.....	—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	—	17.00
Shellac, orange, fine	nominal lb.	1.50	—	.....
Shellac, orange, superfine	lb.	1.60	—	1.65
Shellac, A. C. garnet	lb.	1.30	—	1.35
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	60.00
Talc, imported	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. Works:

Chrome brick	net ton	$75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn.	gross ton	200.00	—	250.00
Spiegeleisen, 16-20% Mn.	gross ton	73.00	—	75.00
Ferro-molybdenum, per lb. of Mo.	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	200.00
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90	—	1.10
Ferro-uranium, 35-50% of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50	—	7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3 f.o.b. Atlantic seaboard	unit	$0.70	—	$0.85
Chrome ore, 48% and over	† unit	.....	—	.....
Coke, foundry, f.o.b. ovens	net ton	12.00	—	14.00
Coke, furnace, f.o.b. ovens	net ton	11.00	—	12.00
Petroleum coke, refinery, Atlantic seaboard	net ton	.....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00	—	30.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00	—	65.00
Manganese ore, 45% Mn and over	unit	.80	—	.95
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	7.50
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore	lb.	1.00	—	3.00
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

*Nominal

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb	$2.45@		$4.00
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45@		4.00
Tees, 3-in. and larger	100 lb.	2.45@		4.00
Plates	100 lb.	2.65@		4.00
Rivets, structural, ¾-in. and larger	100 lb.	4.50		
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.60		
Sheets, No. 28 black	100 lb.	4.35@		6.50
Sheets, No. 10 blue annealed	100 lb.	3.55@		6.00
Sheets, No. 28 galvanized	100 lb.	5.70@		8.50

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SAN DIEGO—The Citrus Soap Co., 9th and K. Sts., is building a 4-story, 200x300-ft. modern manufacturing plant at Union and Market Sts. Estimated cost, $200,000.

Illinois

ROCKFORD — The Emerson-Brantingham Co., South Independence Ave., plans to construct a 1-story, 80x200-ft. annealing plant, cost, $30,000 and a 1-story, 41x100-ft. core room, cost, $9,000.

Iowa

AMES—A. B. Maxwall, city clk., City Hall, will receive bids until June 7 for the construction of a sewage treatment plant consisting of a pumping plant, Imhoff tank, sludge bed, a 100x148-ft. trickling filter, etc. Noted March 10.

COIN—The School Bd. is having plans prepared for the construction of a 3-story, 65x120-ft. school building. A chemical laboratory will be installed in same. Estimated cost, $135,000. C. S. Buchtel, pres., W. Gordon, 319 Hubbell Bldg., Des Moines, archt.

GLIDDEN—The Bd. Educ. has awarded the contract for the construction of a 3-story, 90x162-ft. school building, to W. F. Kucharo & Co., 622 Hubbell Bldg., Des Moines. A chemical laboratory will be installed in same. Estimated cost, $170,654. Noted May 12.

WATERLOO—Deere & Co., 1325 Third Ave., Moline, Ill., has awarded the contract for the construction of a group of foundry buildings including a 120x200-ft. foundry addition, etc., to the Scales Constr. Co. Foundry equipment will be installed in same. Estimated cost, $400,000.

Maryland

LANSDOWNE—The Natl. Steel Rolling Co., 203 Keyser Bldg., Baltimore, will receive bids until June 10 for the construction of a 1-story, 70x140-ft. steel-rolling mill. The company is in the market for rolling mill machinery, etc. Estimated cost, $100,000.

Massachusetts

BROCKTON—The O. A. Miller Tree Co., c/o G. L. Falk, archt., 63 Main St., has awarded the contract for the construction of a 3-story, 55x160-ft. dry kiln plant on Cherry St., to the George Howard & Sons Co., 153 North Main St. Estimated cost, $50,000. Noted April 14.

FLORENCE—The International Silver Co., 48 State St., Meriden, Conn., plans to build a 1-story, 40x86-ft. forge shop. Estimated cost, $25,000.

WAKEFIELD—The Bd. Educ. will soon award the contract for the construction of a 3-story, 210x250-ft. high school on Main St. A chemical laboratory will be installed in same. Estimated cost, $450,000. F. I. Cooper Corp., 33 Cornhill St., Boston, archt.

WEST SPRINGFIELD (Springfield P. O.)—The New England Box Co., Greenfield, has awarded the contract for the construction of a 1-story manufacturing building on Cold Springs Ave., to the E. F. Carlson Co., 244 Main St., Springfield. Estimated cost, $150,000.

WORCESTER—The Rogers Drop Forging Co., Frank St., has awarded the contract for the construction of a forge plant including a 1-story, 60x85-ft. sand blasting building, 1-story, 130x150-ft. forge shop, etc., to the E. D. Ward Co., 82 Foster St. Estimated cost, $125,000.

Michigan

DETROIT—The Acme White Lead & Color Wks., 1768 St. Aubin St., is in the market for machinery including 300 mills to be used in the grinding of paint for the automobile industry.

DETROIT—The Detroit Graphite Co., 12th St., engaged Smith, Hinchman & Grylls, archts., 710 Washington Arcade Bldg., to prepare plans for the construction of a 2-story factory building for the manufacture of paint, on 12th St. Estimated cost, $50,000.

DETROIT—M. E. Wellhalm, 225 Northwestern Ave., is in the market for brick-making equipment for a modern sized outfit.

KALAMAZOO—The Sutherland Paper Co., Lincoln St., has awarded the contract for the construction of a 3-story, 96x375-ft. paper mill, to O. F. Miller.

MUSKEGON HEIGHTS (Muskegon P. O.)—The City Water Comn. engaged Hoad & Decker, engrs., Engineering Bldg., Ann Arbor, to prepare plans for the construction of a well and filtration galleries having a daily capacity of about 500,000 gal. Estimated cost, $50,000.

Minnesota

ELLSWORTH—The city rejected all bids for the construction of sanitary sewers, disposal works including a disposal tank, sludgebed, etc. Estimated cost, $40,000. Druar & Smith, Globe Bldg., St. Paul, engrs. Noted April 21.

Missouri

JEFFERSON CITY—The City Council will soon award the contract for the furnishing of labor and material including an Imhoff tank, etc., for the construction of 3,650 lineal ft. of sanitary sewers, etc.

New Jersey

HALEDON — The Mayor and the Borough Council will receive bids until June 7 for the construction of a reservoir, dam, filter house and clear water basins, etc.

NEWARK—The Bd. Educ., City Hall, will have plans prepared for the construction of a school building on Oliver St. A chemical laboratory will be installed in same. Estimated cost, $400,000. John H. and Wilson C. Ely, Firemans Trust Bldg., archts.

NEWARK—The Bd. Educ., City Hall, will receive bids until June 8 for the construction of a 3-story, 219x222-ft. school building on 1st and 2nd Aves. A chemical laboratory will be installed in same. Estimated cost, $1,125,000. John H. and Wilson C. Ely, Firemans Trusf Bldg., archts.

New York

ALBANY—F. S. Greene, comn., and Irving A. Huie, secy., 55 Lancaster St., will receive bids until June 7 for the furnishing and delivering of lignin or sulphite liquor material for use by the State Highway Comn. in the maintenance and repair of improved highways.

BROOKLYN—J. E. Nitchie, archt., 63 Park Row, New York City, will soon award the contract for the construction of a 4-story, 50x100-ft. factory addition at 73 Otsego St., for the Keystone Varnish Co., 91 Otsego St. Estimated cost, $85,000. Noted April 14.

BROOKLYN—The Valentine Co., 346 Manhattan Ave., has awarded the contract for altering a steel factory for the manufacture of paints on Richardson, Bayard and Lorimer Sts., to Barney Ahlers, 110 West 40th St., New York City. Estimated cost, $50,000.

BUFFALO—The Kimberley Clark Paper Co., Pine St. and Packard Rd., Niagara Falls, has awarded the contract for the construction of a 2-story, 145x458-ft. factory building, to the Lackawanna Bridge Co., Bell and Abby Sts. Estimated cost, $700,000.

BUFFALO—The Natl. Carbon Co., College Ave., Niagara Falls, has awarded the contract for the construction of a 1-story, 25x300-ft. factory, to the John W. Cowper Co., Inc., Fidelity Bldg. Estimated cost, $100,000.

BUFFALO — The Paper Convertible Corp., Niagara Falls, has awarded the contract for the construction of a 2-story, 105x375-ft. factory, to the Lackawanna Bridge Co., Bell and Abby Sts. Estimated cost, $300,000.

FORESTPORT—The Forestport Pulp Mills, Inc., plans to construct additions and make improvements here. Estimated cost, $50,000.

HINCKLEY—The Otsego Falls Paper & Pulp Co. of Fulton has purchased the plant and equipment of the Hinckley Fibre Co. here, and plans to construct a new addition and make improvements at same. Estimated cost, from $250,000 to $300,000. H. L. Paddock, Fulton, pres.

LONG ISLAND CITY—The Drug Products Co., 48 West 4th St., has awarded the contract for the construction of a factory and laboratory on Jackson Ave. and Pierson St., to the Gretsch Eng. Co., 103 Park Ave., New York City. Estimated cost, $175,000.

MASSENA—The Aluminum Co. of America plans to construct additions to its present plant here. Estimated cost, $250,000.

NEW YORK—M. B. Schmidt, archt., 14 East 46th St., will soon award the contract for the construction of a 4-story, 50x50-ft. paint factory on West 58th St., for William Zinsser, West 59th St. Estimated cost, $50,000.

TONAWANDA—The Economy Pulp Mfg. Co. of Buffalo has purchased the vinegar works here and plans to refit and remodel it for a pulp plant. Estimated cost, $50,000.

WELLSVILLE—The village has voted $15,000 bonds to construct an additional filter unit, etc.

Ohio

ALLIANCE—The Bd. Educ. will receive bids until June 7 for the construction of a 3-story, 114x172-ft. school building. A chemical laboratory will be installed in same. Estimated cost, $500,000.

ASHTABULA—Robert Locke, pres., will soon award the contract for the construction of a 1-story, 110x600-ft. sheet steel mill on the State Rd., for the Ashtabula Steel Co. Estimated cost, $350,000.

CLEVELAND—The De Mooy Palmer Co., 65th St. and Sweeney Ave., has awarded the contract for the construction of a 1-story, 50x150-ft. foundry to Ford & Sons Co., foot of East 40th St. Estimated cost, $25,000.

CLEVELAND—The Natl. Malleable Castings Co., Woodhill Rd. and Quincy Ave., has awarded the contract for the construction of a 1-story, 100x500-ft. kiln on Woodhill Rd., to the Amer. Tunnel Co., New Castle, Pa. Estimated cost, $250,000.

COLUMBUS—The Climax Rubber Co., Citizens Bank Bldg., will build a 2-story, 140x190-ft. rubber plant on West Goodale St. Plans include a power plant and office building. Work will be done by day labor. Noted April 21.

EATON—The Bd. of Pub. Affairs will receive bids until June 23 for the construction of a filtration plant, etc. Estimated cost, $27,000. J. H. Beatty, clk.

EUCLID—The village plans to build a sewage disposal plant including settling tanks, screen buildings, etc. Estimated cost, $150,000. G. B. Gascoigne, 618 City Hall, Cleveland, engr.

IRONTON—The Fearon Lumber & Veneer Co. is in the market for dry kiln equipment including seventy-five 6-in. or 6½-in roller-bearing dry kiln trucks (used preferred).

Rhode Island

WOONSOCKET—The Amer. Wringer Co., 91 Social St., will soon award the contract for the construction of three buildings, including a 1-story, 80x100-ft. dry kiln and a 1-story, 60x186-ft. mechanical roll building, etc. Estimated cost, $100,000. Cooley & Marvin Co., 711 Tremont Bldg., Boston, Mass., engrs.

Texas

PALACIAS—The Palacias Sewer Co. will soon receive bids for the construction of a sewage disposal plant. Estimated cost, $35,000.

VERNON—The Victor Pipe Line & Refining Co., Dixon Bldg., plans to build a 1-story, 2,000-bbl. oil refinery, here. Estimated cost, $150,000. J. W. Hudson, dir.

Virginia

BEDFORD—The city has awarded the contract for the construction of a filter plant, storage reservoir, steel tower and tank, etc., to Diehl & Vance, Virginia-Carolina Bldg., Norfolk.

Washington

MICA—The Amer. Firebrick Co. will double the capacity of its plant by building a hotel and kilns. Work will be done by day labor.

WENATCHEE—The city is having plans prepared for the construction of a complete water filtration plant with a daily capacity of 2,500,000 to 3,000,000 gal. Estimated cost, $50,000. M. Zahren, engr.

Wisconsin

GALESVILLE—The Galesville Canning Co., Onalaska, has awarded the contract for the construction of four 1- and 2-story cannery buildings, to J. E. Wallace, La Crosse. Estimated cost, $100,000.

KENOSHA—The Bd. Educ. plans to build a high school. A chemical laboratory will be installed in same. Estimated cost, $500,000.

MILWAUKEE—The Bernert Mfg. Co., 489 12th St., is having preliminary plans prepared for the construction of a 60x120-ft. foundry. Foundry equipment will be installed in same. Joseph Glaser, 713 Caswell Block, archt. Noted May 4.

British Columbia

VANCOUVER—The Vancouver Gas Co., 425 Carroll St., has awarded the contract for the construction of a retort house plant of special units and machinery, to the Wists Gas Improvement Co., Manchester, England. Estimated cost, $340,000.

VICTORIA—The Victoria Gas Co., 1016 Langley St., has awarded the contract for the construction of a retort house plant of special units and machinery, to the Wists Gas Improvement Co., Manchester, England. Estimated cost, $216,000.

Ontario

BRAMPTON—W. Treadgold, engr., is receiving prices on the supply and delivery of two 8x16-ft. horizontal, mechanical pressure filters, etc., for the city. Estimated cost, $35,000.

ELK LAKE—The Matachewan Gold Mines, Ltd., plans to install a 100-ton crushing mill. Estimated cost, $50,000. W. H. Seaman, mgr.

GANANOQUE—The Eastern Ontario Milk Products Co. plans to construct a factory here. Estimated cost, $150,000. Address L. P. Sherwood, Central Chambers, Ottawa.

LONDON—The Bd. Educ. plans to build a high school on Waterloo St. A chemical laboratory will be installed in same. Estimated cost, $500,000. A. A. Langford, chn. L. E. Carrothers, archt.

Coming Meetings and Events

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold a regular meeting June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its twelfth semi-annual meeting as follows: June 28 and 29 will be spent in Montreal, June 30 in Ottawa, July 1 in Ontario, July 2 in Shawinigan Falls, July 3 in La Tuque, July 4 in Chicoutimi and July 5 in Quebec.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS will meet in St. Louis May 27 to 29.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

THE CANADIAN INDUSTRIAL CONGRESS will be held at Victoria, B. C., June 2 to 10.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NEW JERSEY CHEMICAL SOCIETY will hold a regular meeting and ladies' day Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

Industrial Notes

THE NEW JERSEY ZINC CO., New York City, has added to its staff Bushnell Bigelow as assistant general sales manager and Walter I. Hess as manager of Eastern sales.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., announces that L. Brandenburger, of Salt Lake City, who was formerly located in the Walker Bank Bldg., has taken larger quarters at 59 West Broadway.

THE ELYRIA ENAMELED PRODUCTS CO., Elyria, Ohio, has moved its New York office from the Architects Bldg., to 103 Park Ave.

THE DIAMOND POWER SPECIALTY CO., Detroit, Mich., received during January, February and March, 1920, orders to equip a total of 635,200 hp. of boilers and economizers with mechanical soot blowers.

THE GORDON DRYER CORP. announces the removal of its New York offices, formerly located at 39 Cortlandt St., to 1 Liberty St. Announcement is also made of the removal of its Bush Terminal experimental and research laboratory to Providence, R. I., where the main works and offices are located.

EDWARDS F. WILSON, formerly chief chemist and fuel engineer of the Westmoreland Coal Co., at Irwin, Pa., has opened a consulting office and testing laboratory at 222 South Third St., Philadelphia, where he will specialize in fuels, iron and steel, industrial water, etc., reopening in this connection the business of the Iron-Masters' Laboratory, of which he was formerly in charge.

THE ATMOSPHERIC CONDITIONING CORP., Philadelphia, Pa., announces the appointment of Benjamin Nelson as Western manager, with offices at 1301 Monadnock Block, Chicago, Ill.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, Ohio, has elected John A. Penton, president of the Penton Publishing Co., a director to fill the vacancy on the board caused by the death of Samuel T. Wellman.

GUY FRIDLEY, formerly in charge of the fertilizer department of the Davidson Commission Co., Chicago, Ill., is now president and general manager of the Fridley Commission Co., Inc., Chicago, which company both sells and buys fertilizer materials.

R. A. BROWN, president of the Alabama State Fair Association and president of the Chamber of Commerce, Birmingham, Ala., has been elected president of the Steel Cities Chemical Co. He succeeds his uncle, the later Culpeper Exum.

WELLS, BECKWITH & COLE is a new firm of architects and engineers that has been formed at Detroit, with Dalton R. Wells president, Donald Cole vice-president and Harry G. Beckwith secretary-treasurer. The offices of the new firm will be located at 624 McKerchy Bldg., Detroit.

THE CAMPBELL GLASS & PAINT CO. and the GLIDDEN VARNISH CO. have established a branch office in Oklahoma City at 18 N. Lee St. Parker Spencer will be in charge of the distribution of products in this territory.

THE ESTES MFG. CO., of Omaha, Neb., has established a branch sales office at 132 West Second St., Oklahoma City, in charge of J. S. Kotva.

THE O'REILLEY-LEEWRIGHT CO. has established a manufacturing plant at Oklahoma City for the production of paint and roofing compounds.

THE NATIONAL BUREAU OF WHOLESALE LUMBER DISTRIBUTORS will move its headquarters from Washington, D. C., to Chicago, locating in the Arcade Bldg., 615 South Michigan Ave. L. R. Putman, formerly with the Southern Pine Assn., has been retained by the new association as executive secretary.

THE SERVICE MACHINE CORP. has moved its plant to 449-51 E. Ohio St., Chicago, Ill.

THE MERCANTILE CHEMICAL CO. has established a new plant at 2955 W. 47th St., Chicago, Ill.

THE RELIANCE WEIGHING MACHINE CO., maker of automatic recording weighing machinery, has purchased the business of the National Automatic Scale Co. New quarters for the organization have been provided in the Mallers Bldg., Chicago, and the company's factory in the central manufacturing district of Chicago will be greatly enlarged.

THE MONROE STEEL CASTINGS CO., Monroe, Mich., has sold its capital stock and physical assets to Detroit interests. The capacity of the plant will be immediately increased for the production of a general line of steel castings. Carl Clark is president and general manager of the new company.

THE METAL & THERMIT CORP., New York, announces the appointment of Charles F. Lederer in the rail welding department.

THE GENERAL BRIQUETTING CO., New York City, announces that Henry Schoch, sales engineer, has been elected vice-president of the Nukol Fuel Co. of Ontario, Canada. The Nukol Fuel Co. is manufacturing "Nukol," an anthracite briquet, for the Ontario market.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has appointed A. E. Hitchnic, formerly manager mining section, industrial department, to the position of assistant to the manager, industrial department, in charge of mining and chemical industries.

THE SCHAFFER ENGINEERING & EQUIPMENT CO., Pittsburgh, Pa., in order to provide for the expansion of its business and to obtain plant facilities, has sold a large block of its capital stock to the Fawcus Machine Co. The Schaffer Company's processes, engineering achievements and line of machinery include poidometers, hydrators, coal injectors and screens. The Fawcus Machine Co., manufacturer of gears and special types of machinery, with large plants at Pittsburgh and Ford City, will build all machinery required. The new officers and directors of the Schaffer Engineering & Equipment Co. are: A. F. Cooke, president and general manager; J. C. Schaffer, vice-president; Eliot A. Kebler, vice-president; A. A. Alles, Jr., treasurer, and Waller Crow, secretary.

THE PAGE STEEL & WIRE CO. announces the removal of its offices to the offices of the American Chain Co., with which it has consolidated, in the Grand Central Terminal, New York.

THE GENERAL COMBUSTION CO., Chicago, Ill., announces the appointment of George R. Brandon, formerly engaged in engineering and sales of foundry equipment and cranes, as district representative and sales engineer. The General Combustion Co. manufactures "Oilgas" furnaces for all industrial purposes. Mr. Brandon's headquarters will be 342 Monadnock Bldg., Chicago.

S. S. HEPWORTH CO., New York City has appointed C. A. Olcott general manager and E. F. Babbitt asistant manager, effective June 1, 1920.

THE WALTER E. LUMMUS CO., Boston, Mass., has appointed Raymond R. Collins, formerly head of the construction department, as sales manager.

HANFF-METZGER, INC., general advertising agent, New York, has appointed Francis Juraschek head of its technical department.

THE IMPROVED EQUIPMENT CO. announces the removal of its offices to 24 State St., New York City, on May 1, 1920.

THE WORTHINGTON PUMP & MACHINERY CORP., New York, announces that in addition to its lines of hydraulic machinery it can furnish improved water-power machinery of all capacities for low, medium and high head service, including oil pressure system, water wheel governors and other auxiliaries. It is equipped to produce hydraulic turbines, and an experienced staff has been secured to take care of tnis department.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., announces that George E. Long, senior vice-president, is retiring from that office, but will continue as a member of the board of directors.

THE ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, reports a repeat order for a 1½-ton Greaves-Etchells furnace from Charles Bertolus, St. Etienne, France; a new order for a G-E ½-ton electric furnace for A. Hamilton & Son, Cardiff, for the manufacture of castings; and the closing of a contract with the Emery Steel Co., Baltimore, Md., for an electric furnace of new design for annealing steel castings. Announcement is also made of an electrode cooling ring and economizer, which effectively prevents the ignition of the hot gases escaping from the furnace roof. The net result of this is considerable saving in the wear of the furnace roof, and also great economy in the amount of electrodes consumed.

Manufacturers' Catalogs

THE STANDARD ELECTRIC & ELEVATOR Co., Baltimore, Md., has issued a very attractive 80-page catalog entitled "Modernizing America's Industries." It suggests methods for industrial modernization and gives facts that should be of value to officials, managers, production engineers and maintenance engineers. Many illustrations are given, among which are some of the officials of the company, interior of several departments, together with their products, and descriptive matter.

THE READING VALVE FITTINGS Co., Reading, Pa., has issued a catalog of steel and iron flanged and screwed fittings and flanges.

THE W. S. ROCKWELL Co., New York, announces six new publications. No. 209 is entitled "Automatic Hardening and Tempering Furnaces"; No. 210, "Worth-While Facts for Users of Blast Gates"; No. 211, "Saw-Hardening Furnace"; No. 212, "Spring-Fitting Furnaces"; No. 213, "Drop Forging Equipment and Layout," and No. 216, "Factors to Be Considered in Heating and Cooling Steel." The last publication mentioned has been written for the benefit of the man in charge of shop operations, and attempts to express the principles governing heat-treatment work.

THE STEERE ENGINEERING Co., Detroit, Mich., announces three pamphlets, on electrically welded steel pipe and fittings, cooling coils, and welded steel piping.

THE HIRES TURNER GLASS Co., Philadelphia, Pa., calls attention to a very attractive catalog on "Glass for Every Industry." This catalog, which deals with "Lighthouse" quality glass and accessories, is published in four languages: English, Spanish, French and Portuguese, and has been prepared for the convenience and information of purchasers. Complete information and illustrations are given for glass for building and other accessory purposes, including plate glass, window glass, wire glass, rolled glass, "Saftee" glass, etc.

THE NEW YORK TESTING LABORATORIES, New York City, is distributing a four-page folder on Metallurgical Service.

THE STAR BRASS WORKS, Chicago, now has ready for distribution a 24-page bulletin, 4-A, covering spray cooling equipment for the cooling of water from steam and ammonia condensers. This literature gives illustrations of many recent installations, in addition to information respecting spray cooling systems for power and industrial plants.

THE DURIRON CASTINGS Co., Dayton, Ohio, announces Bulletin 111, on comparative tests on vitrified tile pipe, lead pipe and Duriron pipe, conducted by the testing laboratories of the school of engineering of Columbia University, November, 1919.

WILLIAM GAERTNER & Co., Chicago, Ill., calls attention to two catalogs. Catalog M illustrates and describes instruments of precision, such as measuring microscopes, comparators, cathetometers, etc. Catalog L, on optical instruments, illustrates and describes spectrometers, spectroscopes, optical benches, photometers, etc.

THE WHEELER CONDESER & ENGINEERING Co., Carteret, N. J., has published the 1920 edition of Steam Tables for Condenser Work. The book gives the properties of saturated steam from 29.8-in. vacuum to atmospheric pressure in increments of tenths of an inch. The vacuum in inches of mercury is referred to a 30-in. barometer. This method is of course superior to the old method of giving absolute pressures in pounds per square inch, since it is customary to read vacuum in inches of mercury. A complete table is also given of the properties of saturated steam above atmospheric pressure. The pressures below atmosphere have been especially calculated for this book by Prof. Marks.

THE BRIDGEPORT BRASS Co., Bridgeport, Conn., has prepared a book on "Brass." The book, which is most excellently printed and illustrated, describes in detail the art of brass making, dating back hundreds of years, leading up to the most modern practices as in use in the Bridgeport Brass Co.'s plant, including the electric casting shop. The important steps in the making of tubes, sheet, rods and wire are also shown. Following a full description of the modern methods of manufacture, which includes some details of methods not commonly found in print, the properties of brass are briefly noted as they are affected by composition, cold-working and heat treatment. This section should assist engineers in drawing specifications. In the compilation of this work the .company has deviated from fixed conventions and traditions of the brass industry by making an open book of the practices and processes of brass making. It is extremely well written, and there are few even who have been associated with the brass industry for years who would not find it a valuable addition to their library.

THE METAL & THERMIT CORP., New York, has issued a third and revised edition of its pamphlet entitled "Laboratory Experiments With the Thermit Process of Welding." This pamphlet is useful as a guide for acquainting students with the substance, characteristics and results of the Thermit reaction. The pamphlet illustrates and describes various experiments which are intended to show the speed of the reaction, the heat produced thereby and the effects obtained by the superheated liquid slag and the superheated liquid steel.

WILLIAM R. PERRIN & Co., Chicago, Ill., calls attention to a new pamphlet on filter presses. This four-page pamphlet illustrates and describes filter presses of various designs, gives a table of sizes, working pressure, weights, etc., filter presses with square plate and frames, and a separate sheet is inclosed on recessed filter plates and flat filter plates and extension frames.

NATIONAL ENGINEERING Co., Chicago, Ill., has published a catalog on the National Screen Separator, which contains eight pages of illustrations and descriptive matter.

BAUSCH & LOMB OPTICAL Co., Rochester, N. Y., calls attention to an attractive 64-page catalog on Photographic Lenses. Many interesting illustrations are given, together with descriptive matter.

EDWARD R. LADEW Co., INC., Glen Cove, N. Y.: "Ladew Leathers" is the title of a 56-page book which illustrates and describes different kinds of belts, with price lists, automobile leathers, whole leather, leather packings, pump leathers, leather shafting rings, rub roll aprons, mill strapping, etc.

THE BLAW-KNOX Co., Pittsburgh, Pa., started in April, 1920, the monthly publication of *Blaw-Knox Life*. The May issue is out now and both issues are very interesting.

THE PFAUDLER Co., Rochester, N. Y., has issued a 32-page booklet, Bulletin C-5, on glass enameled steel equipment for the chemical industries which is designed to give a comprehensive idea of the application of glass enameled steel equipment and apparatus to the manufacture and handling of corrosive and sensitive liquids. Each illustration shows either a standard type or a characteristic feature.

ALLDAYS & ONIONS, LTD., Birmingham, England, is issuing a 4-page pamphlet on Oil-Firing for Boilers, which deals with its patent oil burners, giving diagrams and full particulars of a number of characteristic conversions to liquid fuel.

THE GRISCOM-RUSSELL Co., New York, is issuing Bulletin No. 902, on Multi-whirl Cooler, which is for the cooling of oil used in the lubrication of turbine bearings, reduction gears or quenching oil in the heat treating of steel. In either case the oil is constantly circulated through the cooler, thus maintaining the oil at a constant temperature and permitting the continued use of the original quantity of oil and its maintenance at the proper viscosity for efficient results. The apparatus takes its name from the whirling path of the oil, which path is accomplished by the use of the helical baffle which directs the oil in its flow without appreciably retarding its progress. This baffle also serves to bring the oil into intimate contact with the cooling surface and it insures a high rate of heat transfer. The shell is of cast iron and the tubes of seamless drawn brass or copper, expanded into a fixed tube plate at one end and into a floating head at the other which latter permits expansion and contraction without strain on the tube joints. The cooling of quenching oil insures maintenance of the quenching bath at a fixed temperature and also permits the use of cheaper grade oil.

THE DU PONT CHEMICAL Co., Wilmington, Del., is distributing a booklet entitled "The Way to Increased Production," which gives some facts in regard to the company's gigantic sale of war surplus material. Although the book is by no means complete as an inventory of the matrial on hand, it nevertheless does give an idea of the mountains of supplies handled by this organization. The du Pont Chemical Co. took over the supplies and equipment of the war plants of the du Pont Co., and some idea of the magnitude of the work involved can be had when it is considered that the inventories of the various plants developed something more than 70,000 cards, consisting of from one to a dozen separate items. In all, it was found that there were more than 500,000 different items of material and equipment available for sale, and these include an enormous range of articles in daily use, covering a little of everything, from pins to platinum. General machinery of all kinds is on hand, and there is also special machinery built for manufacturing purposes peculiar to the powder business but which can, in many instances, be used in other industries with slight changes. The du Pont Chemical Co. is now engaged in a national advertising campaign to sell these materials and the stocks are moving fast. The pamphlet ought to be a valuable handbook for buyers in every line in the present state of the market.

EIMER & AMEND, New York City, has issued two new bulletins. Bulletin No. 268 is entitled "The Hortvet Cryoscope," which is of importance in the testing of milk. Bulletin 269 is entitled "American Rotary Vacuum Pumps and the MacLeod Vacuum Gauge."

NICKLE ENGINEERING WORKS, Saginaw, Mich., announces a new bulletin entitled "Agitator Driving Yokes," a standard power transmission device—made in several styles and sizes—for driving agitator or stirrer shafts in chemical tanks and kettles. Illustrations show how these driving yokes are mounted on both open and closed containers. A table of dimensions, convenient for draftsmen, is also given.

H. R. WAHL & Co., Chicago, Ill., has published a catalog describing a new type of machine, adapted to such work as dewatering, classifying and washing ores or other granular material, known as the Wahl dewatering machine.

THE JOINTLESS FIRE BRICK Co., Chicago, Ill., is distributing a booklet entitled "General Information for Installing Plibrico Jointless Fire Brick."

THE ESTERLINE Co., Indianapolis, Ind., in the *Esterline Graphic* treats the subject of Graphic Instruments in the Field of Transportation. The company says that many people think a curve drawing meter is a delicate, sensitive instrument which must be handled by an expert with the greatest care, but that the Esterline graphic instruments have given satisfactory service under the severe conditions as described in this pamphlet.